Biodiversity Use at the Crossroads

Can we sustainably use biodiversity?

by Prof. Dr. Steven de Bie

Inaugural lecture (presented in abridged form),
1 March 2007

WAGENINGEN UR
For quality of life

To my father, who learned me that making one step extra, beyond what you think is possible, opens the door to a world full of unknown opportunities.

Colofon

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Introduction

Mr. Rector Magnificus, ladies and gentlemen,

Mr. Rector Magnificus, almost a year ago to this day I did not attend the Dies Natalis of this University, despite your kind invitation.
At that time I found myself on an exciting trip through Southern Africa and South America.
I started in Mozambique where regional, integrated coastal development is high on the political agenda. Knowledge of robust stakeholder engagement and conflict resolution is an essential attribute to strategic environmental assessment, in order to determine options for sustainable natural resource use. Strategic environmental assessment is an important tool in the decision making process, especially where the economic development of coastal natural resources is further complicated by traditional use and local culture. I was involved in a training programme that helped representatives from ministries and NGOs to understand these processes and how to apply such knowledge in effective integrated coastal development.

Thereafter I travelled to South Africa, to the Ithala Game Reserve and Kruger National Park. This time my agenda was scientific: first the search for sites suitable to investigate how larger animals that evolved in climatically stable tropical conditions have adapted as the climate has become harsher and more variable. The ultimate goal was to understand if and how

Greater kudu in Krüger National Park (South Africa)

animals might adapt to climate change. The second reason was to discuss experiments that will help us to unravel the savanna dilemma: is there competition for water and nutrients between grasses and trees in the savanna, and what is the role of large trees as nutrient pumps in that ecosystem? Two questions that must be answered before we can even think of sustainably using savannas.

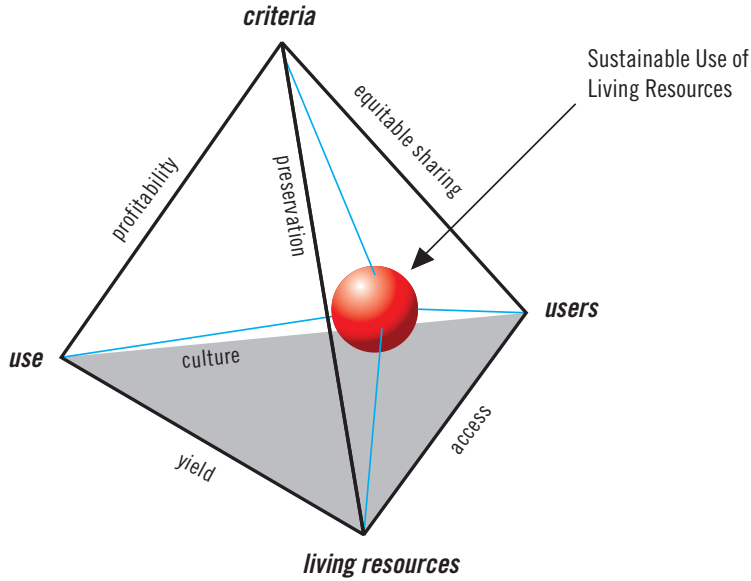
And then I continued my trip to South America, to the city of Curitiba in Brazil. That was where the Parties to the United Nations Convention on Biological Diversity – the CBD – came together for their 8th conference since the adoption of the Convention in Rio de Janeiro in 1992. I had the privilege to be part of the official Dutch delegation representing the private sector. The Parties discussed the various programmes of work, progress since their last conference, and financing. They adopted a decision that called for the active involvement of the private sector in the agenda of the Convention, despite some opposition from NGOs (= non-governmental organizations). Parties acknowledged the role of the private sector in the conservation and sustainable use of biodiversity.

These very different activities on this trip have in common that they all relate to the sustainable use of living resources or biodiversity. Research,

legislation, political framework and capacity building are all different but equally important facets of this subject. They demonstrate that the subject is at the interface between science and society, business and politics, education and research. It is a fascinating and challenging subject, and the chair to which I have been officially appointed, and that we inaugurate today, has this subject as its focus area.

Inaugural lectures traditionally present a vision on the discipline: what is going on, what are major challenges, and equally if not more important, what makes it so fascinating. Ordinary professors have a lectureship that is well defined in terms of research domain and its particular niche among other chairs in and outside the University. In my position of honorary professor, such a lectureship is less defined. It is more open to following developments than determining what should be done and what not.

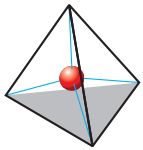
Therefore, I see this inaugural lecture as an opportunity and privilege to share with you my vision on my lectureship, its societal value, the challenges we face and where we might make exciting progress in the research topics I have started.
I start by sketching what is meant by the adjective 'sustainable' or the verb 'to sustain'. Thereafter I will elaborate the main elements of the lectureship, using the sustainable use pyramid as a conceptual model (figure 1).



use = economy
users = socio-cultural environment
living resources = natural environment (ecology)
criteria = norms and values

Figure 1: The Sustainable Use Pyramid

After highlighting the lines of research I will pursue over the years to come and the meaning of all this for education, I conclude this inaugural lecture with some words of thanks.



What is this word ‘sustainable’?

Ladies and gentlemen, I want to say a few words about the word sustainable as it sets the context for what will follow, in particular because it is used so often and interpreted in so many ways that it can becomes meaningless.

In my view, the way we live as a global human society is unsustainable. The social and economic choices we make place a heavy burden on natural systems and their processes that increasingly exceed the carrying capacity of this planet.
It was the publication *The Limits to Growth* by the Club of Rome in 1972 that stirred the world with its message that there are environmental limits to man’s activities (5).
The theme ‘sustainable development’ was coined at the UN Conference on the Human Environment (Stockholm 1972).
In 1980 three international organizations, IUCN, UNEP and WWF, launched the World Conservation Strategy in which they pledged the conservation of living resources for sustainable development (6). Living resources are those resources in our environment, such as species and ecosystems that are renewable, in short biodiversity.
The Brundtland Commission (7) not only borrowed the phrase but by defining sustainable development as *“Meeting the needs of the present without compromising the ability of future generations to meet their own needs”* also explicitly emphasized the link between sustainability and economic growth, while adding the time dimension .

Nowadays, global sustainability and sustainable development are in the vocabulary of all world leaders, on the agenda of politicians, and frequently in the media. However, behind the use of the phrase ‘sustainable development’ are very divergent ideas on how our environment, our economy and our social capital in their mutual coherence should be managed. It is an attractive, but flexible and imprecise term. Although the term has appeared to be inadequate to drive the transition to a world where economic development and environmental conservation are more aligned, and acknowl-

edging that there is a need for a new approach or concept, the fundamental point still remains valid: the capacity of our environment to yield ecosystem services such as products for our consumption and to absorb our waste, is limited.

The CBD has defined 'sustainable use' of biodiversity as one of its three objectives. In the various programmes of work related to this objective, the Convention focuses on the sustainable exploitation of living resources (genes, individual organisms, populations, species and ecosystems) using sustainable use principles (the so-called Addis Ababa Principles adopted by the Conference of Parties in 2004) as the tool to achieve that goal.

Also the term 'sustainable use' has evolved over time. Whereas it started to be limited to the harvest of renewable wild living resources (IUCN, General Assembly, Perth (Australia) 1990), the number of meanings has grown since. Nowadays, it is being referred to as sustainable management, sustainable consumption, sustained yield, and even as the sustained use of non-renewable resources, which is a contradiction in itself!

I define sustainable use as the 'consumptive and non-consumptive use of biodiversity in such a way that biodiversity is maintained over time. In financial terms: to use only interest not capital. However, in biodiversity both capital and interest are not fixed entities as fluctuating food resources and changing environmental conditions impact upon them. This means that often one can only use part of the interest in order to let the capital grow for building safety margins.

The context: loss of biodiversity and erosion of ecosystem services

Mr. Rector Magnificus, global biodiversity is increasingly under pressure by human activities and over the passed decades many species have become extinct (figure 2).

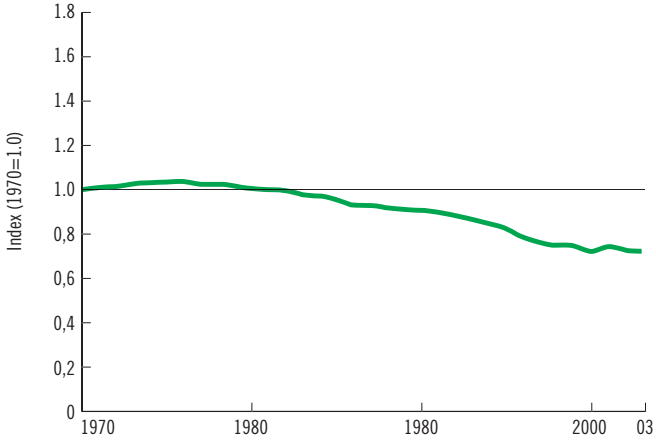


Figure 2: Living Planet Index; trends in populations of terrestrial, marine and freshwater vertebrate species; it declined by 29 per cent from 1970 to 2003 (WWF, 2006)

We have heard this before, and we will hear it again. We witness extensive fragmentation and loss of natural habitat, rapid rates of deforestation, degradation of fragile ecosystems and climate change, to name but a few of the main drivers for this loss. Most are, directly or indirectly, the result of man's activities. The extinction of species and even the contraction of major ecosystems such as tropical rainforest, tundra and permanent ice, are the inevitable outcome of this change in our environment. The statistics are perhaps not all that pertinent, but the trends are worrying, and the effects of continuing habitat loss and fragmentation are only just starting to manifest themselves.

Despite numerous multi-lateral, regional and national agreements, laws and conventions, biodiversity loss continues. In Europe and in South and East Asia that loss is about 50%. In our own country, only 20% of the

original or low-impacted biodiversity remains (1). The World Summit on Sustainable Development in 2002 adopted the goal of securing by 2010 a significant reduction in the current rate of biodiversity loss. However, population growth and with it the social and economic demands of the increasingly industrialized and developing world, are obstacles to conserve biodiversity.
In May 2005 the Millennium Ecosystem Assessment published the results of a global assessment of the status of the world's ecosystems. It signalled the severe degradation of 60% of the services these ecosystems provide (2). These services comprise supporting, provisioning, regulating and cultural services. The use of these ecosystem services for direct consumption, as raw material and as sinks for waste materials is high and growing. The global human footprint, the global significance and scale of that use, is beyond any doubt, and exceeds the earth's biological capacity already by about 25% (3,4).

One of the greatest challenges that we, governments, corporate organizations, local communities and individual persons face this century, is making man's use of living resources, biodiversity, sustainable. The CBD lists sustainable use as one of its three objectives. The other two are conservation of biodiversity and the equitable sharing of the benefits of its exploitation. The Convention focuses primarily on the living component of biodiversity, and consequently, the debate of sustainable use concentrates on the question if and how this biodiversity component (genes, individual organisms, populations, species, and communities of species) could be exploited sustainably.

There is an ecological component to sustainable biodiversity use: what can be used, under which conditions and to what level? Also, there is a socio-cultural component: who is making use of biodiversity, in what ways, in which situations, and why? And there is an economic component to it as well: what are the costs of exploitation and what is the value in relation to exploitation types. These components come together in what we call 'exploitation strategy'.
One finds two main exploitation strategies for biodiversity exploitation, one that relates to the individual-based ownership of biodiversity or its right of use (e.g. cultivation of food crops), and the second in which biodiversity is

considered as 'wild', 'free for all', having no clear ownership (*res nullius*) or forms of ownership that are *common*, *fugitive* or even *open access*.

Quite a few knowledge centres within Wageningen University study the various aspects of the first strategy, but hardly any group takes the second strategy as their research domain. As part of my work I will specifically address these 'wild resources', asking questions like:

- what is required to maintain this biodiversity and ecosystem services?
- what are the strong and the weak points of present exploitation, and are there new concepts we could develop as well as tools?
- what exploitation strategies must be developed for the sustainable use of biodiversity?
- how much do such strategies differ in situations of multi-species (e.g. wildlife in conservation areas) from the traditional single-species models?
- what are the effects of scale related to this use of biodiversity?

We need to analyse and understand the structure and functioning of living resources, and the impact of mankind on them before starting to develop ways of sustainably using those resources.

Living Resources: looking through the ecological lens

Living resources contain the whole spectrum from genes and individual organisms to species and ecosystems, and are synonymous with biodiversity. In contrast to the abiotic, non-living resources such as oil, natural gas, iron ore and sand, these living resources or biodiversity are renewable if used sustainably. Such a sustainable use of biodiversity, both consumptive and non-consumptive, means that one needs to have a notion of which internal and external factors regulate the distribution, appearance and abundance of the resource, e.g. population size, reproduction and mortality rates, diversity and structure, etc. Also, how species, populations and ecosystems cope with disturbance and whether they can recover from these disturbances. Sustainable use requires an understanding of the regulating factors underlying the occurrence of species and ecosystems and playing with it in such a way that it delivers what is desired and continues doing so. I will discuss some of the ecological concepts that are fundamental in understanding what sustainable use of biodiversity might be.

Spitsbergen reindeer in Adventdalen

In 1977 I joined an expedition to the Spitsbergen group of islands, north of Norway in the Arctic Ocean, which kindled my interest in the concept of carrying

capacity. This expedition was to study how wild reindeer could survive on these arctic islands in the absence of predators and without any possibilities for large-scale migration. How are their numbers regulated and how many could at maximum live there? Simply defined it relates to the number of organisms that can live on a certain resource under a set of environmental conditions over an indefinite period of time.
The availability of nutritious plants in summer, an animal's ability to convert this material into a thick layer of subcutaneous fat, and late winter weather conditions determine the population size of the Spitsbergen reindeer; a relatively simple ecosystem. Generally ecosystems are more complex. Comparable research that I carried out later in Africa and Southeast Asia revealed that a large variety of factors can be involved in the ultimate carrying capacity, e.g. the availability of food to offspring at the time of weaning, access to surface water, the quantity of food of a certain quality at various periods of the year, species assemblage and sometimes predation. Recently we started a research project to understand how animals that have evolved under dry, tropical conditions change behaviourally and physiologically to minimise energy loss if exposed to different and fluctuating climatic conditions. So far this eco-physiological aspect of population dynamics has received hardly any attention although it is probably as important as the optimal foraging and anti-predation strategies for understanding animal numbers and distribution.

The carrying capacity concept is sometimes viewed as outdated. In my opinion the basic idea still has value and if we discuss harvestable levels of biodiversity, we need to know the carrying capacity of the system under consideration. In the farmer's words, the stocking rates. The analysis of the carrying capacity of an ecosystem or landscape inevitably requires an understanding of the relationships between its components and feedback processes. Our eco-physiological project illustrates that this picture is still incomplete.

In the early 1980's I worked as an animal ecologist in a wildlife utilization project in Mali, West Africa. At that time the Sahelian countries suffered from a drought that started in 1970 and extended well into the 80's. In

those years, the average annual rainfall was about 60% of that in the period 1900-1969. Die-off of cattle, crop failure, famine and enhanced human mortality were not uncommon sights in the arid and semi-arid region between Senegal and Cameroon. This drought enabled us to study the effects of a prolonged period of reduced rainfall on the steppe and savanna ecosystems. Whereas the steppe vegetation (dominated by annual grasses) showed annual variation in plant species composition and production, we noticed that the savanna vegetation (dominated by perennial grasses) initially showed only marginal reaction up to a certain point and then completely changed. This example brings us to the subject of ecosystem dynamics, stability and resilience.

Ecosystems have for long been thought as being 'homeostatic', i.e. having a certain degree of constancy over time. Ecosystems are self-organizing: their dynamics are largely a function of positive and negative feedback mechanisms. An ecosystem changes due to (short-lasting) disturbance but once this stress is removed, the system will bounce back to its former state due to negative feedback mechanisms.

But the science of ecology has moved on and today we know that non-linear relationships are an integral part of ecosystem functioning.
Ecosystems can absorb some degree of (recurrent) natural or human intervention and recover from it without slowly degrading or unexpectedly flipping into alternate stages. They show resilience. Initially, resilience was defined as the ability of an ecosystem to absorb change and disturbance without qualitative change in its basic functional organisation (8). Ecosystems, however, have different degrees of hysteresis: i.e. the recovery may follow a different trajectory from that observed during the disturbance or decline and often at a different rate (figure 3a).

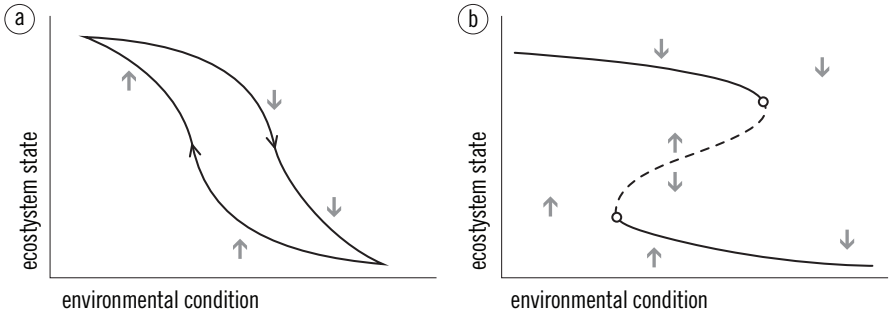


Figure 3: Hysteresis

Some ecosystems change due to e.g. a prolonged period or severity of the disturbance, to such an extent that they can no longer recover to the original state; they flip into an alternate state (9). Such change is often rapid and 'catastrophic'. Polluted lakes do not necessarily return to their former state when pollution stops and clean-up activities have been completed. Savannas degraded due to overgrazing do not easily return to their former state but stay captured in another state of equilibrium (10). Analysis shows that such ecosystems have crossed a threshold into a new 'domain of attraction' (or regime) that precludes the return to the original state unless under specific conditions: bimodality (figure 3b).

Each domain is being maintained through a different set of processes and structures, and has its own resilience. Resilience could then also be defined as the amount of change or disruption that will cause an ecosystem to switch from one set of mutually reinforcing processes and structures to an alternative set of processes and structures (9). This so-called fold catastrophe model has four properties:

- bimodality: the ecosystem is characterized by one of the two states,
- discontinuity: there is nothing in between those two states,
- hysteresis: a delayed response to a changing variable or factor, and the response to the change follows one path when the change in the factor increases, and a different one when it decreases, and
- divergence: nearby starting conditions evolve to widely separated final states.

West African savanna in two alternate states of stability:
a – high productivity, and high diversity
b – low productivity, low diversity after prolonged period of drought and overgrazing

So far we have implicitly assumed that only one variable is involved in this dynamics. If we introduce a second system variable then this *fold catastrophe* becomes a *cusp catastrophe* initially developed by Loehle (11) (figure 4). It shows that in one and the same ecosystem the response can be both a gradual displacement and an abrupt one.

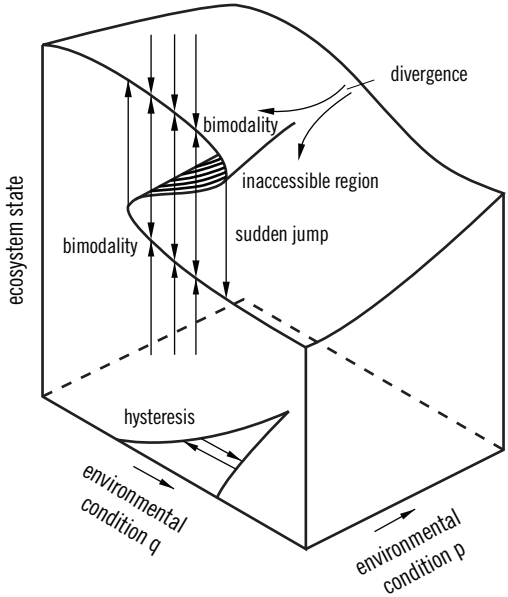
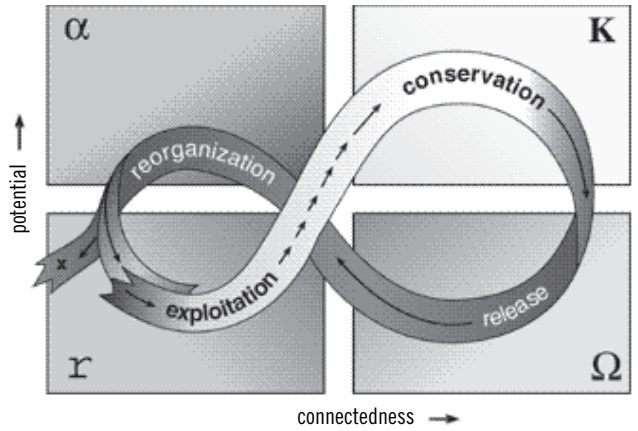


Figure 4: The cusp catastrophe model

Thus ecosystems do not have a single equilibrium, multiple equilibriums are more common. Ecosystems have processes that maintain stability in terms of productivity and nutrient cycling, but also ones that destabilize. Change in ecosystems is neither gradual nor continuous; regulated interactions between slow and fast variables.

The concept of ecosystem dynamics has evolved further. The traditional view of ecosystem succession was of one that contains two stages, exploitation (r) and conservation (K). Progressing ecological research has made clear that two more stages should be added: release (or destruction, Ω) and reorganization (α) (figure 5) (12).



y-axis: Potential that is inherent in the accumulated resources of biomass and nutrients

x-axis: The degree of connectedness among controlling variables

Figure 5: The adaptive cycle (Gunderson & Holling, 2002)

The exploitation stage is one of rapid expansion, e.g. when a population finds a fertile niche for rapid expansion. The conservation stage is when energy and material are slowly accumulated and stored; the population reaches carrying capacity and stabilizes for a time. In the release stage the population declines rapidly due to e.g. changing environmental conditions. If individual members of the population are able to survive despite the changed conditions, a stage of reorganization can start. This so-called adaptive cycle is the process that accounts for both the stability and change in complex ecosystems.
This adaptive cycle concept provides a better way to understand resilience, how and why different ecosystem regimes emerge, and their likelihood. Resilience does not necessarily remain constant over the adaptive cycle.

The important question to address in our research is: does this resilience approach and related concepts and models capture the behaviour of an ecosystem under different stress levels adequately enough to help us understand what an intervention really is, will they enable us to assess levels of sustainable use, and will they help us in identifying ways to restore degraded systems?

The importance of understanding the driving forces of ecosystems for their sustainable use is obvious. Quantitatively, the exploitation of a resource should be within the realm of resilience as repairing it after a shift to another phase, with a lower level of sustainable exploitation will be difficult. Also, localized short-term reductions of human interventions and impacts on a resource will not ensure this resource to recover to its natural state. Nor will the absence of recovery of a resource a few years after overexploitation has stopped, prove that something else has caused the decline of this resource (something we hear when discussing a ban on fisheries). The challenge is to provide those that impact biodiversity, through consumptive use and other, non-consumptive ways, with sound science-based knowledge to enable the sustainable use.

Another scientific challenge to the sustainable use of living resources is the aspect of scale (figure 6). Scale is defined as a range of spatial and temporal frequencies (13). Many ecological studies focus on a single or selected number of species, usually on very limited scales of time and space.

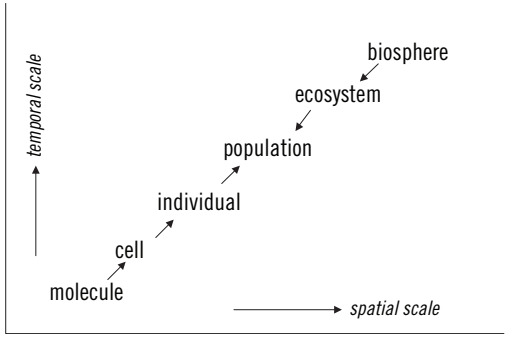


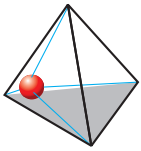
Figure 6: Relationship between processes at different biological organizational levels

Consequently, the processes and properties described are local. I have explained that ecological processes are usually non-linear. Therefore it is difficult when scaling up, to predict the aggregate of a local non-linear process when combined with spatial heterogeneity. Similarly, different organizational properties emerge when scaling up: gender at the level of a species' individual to territoriality at population level. Also different processes

dominate at different scales: light, nutrients and competition with grasses determine the growth of an individual tree in the savanna, whereas bush fires and elephant density operate at the level of savanna woodland, shaping its structure and composition. Consequently, any method for scaling up a local process needs to incorporate the effects of an increasing number of processes as well. These processes usually operate at different rates and are often connected.
Such aspects complicate the scaling process. And if scaling relationships are found, we have to consider the link between scaling and resilience: if an intervention alters the resilience of an ecosystem, then it may shift the scaling relationship as well, reducing or expanding the range of scales over which the relationship applies. The same applies when an ecosystem shifts from one stable state to another: as different processes underlie the functioning of that state, scaling relationships will change accordingly.

Since the 1970's the Biological Dynamics of Forest Fragments Project, a collaborative programme between Brazil and US, studies the structure of tropical forest communities and the stability of forest fragments of different sizes. The scaling results led recently to the conclusion that within 15 years after becoming isolated many forest fragments of different size loose species. When relating time to area, only large fragments (>1000 ha) retain most of their species long enough to offer hope for effective measures if habitat for recolonization is nearby (14). We need to do more work to assess the validity of this scaling effect for other biomes.

I have given you an insight into a few of the concepts we need to work on for a better understanding of the scientific background of sustainable use of biodiversity. Other topics under this heading that require research are the nutrient cycling in ecosystems, the dynamics of functional species assemblages, the presence of key species as conditional for maintaining a high level of biodiversity, etc. There are ample opportunities for new, innovative and exciting studies!



Use: intervening in the functioning of natural ecosystems

We talk about the use of natural resources, sustainable use, etc. without describing or defining what that is. Under this label there is a vast array of topics and I will address just a few of them to give you a flavour of this subject, especially where I think the challenges are with respect to research and education.

What is use? Is it the extraction of honey by local farmers from wild bee nests, made in manmade beehives? Is it tourists enjoying a foreign landscape or wild animals in their natural habitat, is it the cull of elephants as part of a management programme, is it commercial fishing or agriculture? Yes, I would say. Is it using the resource as an offset against human impact made elsewhere? Probably as well and much more. I define 'use' as the extraction of goods and profiting of services from living resources, the natural environment, to fulfil people's needs for food, fibre, water, medicine, information, etc. And the way this use is shaped and its intensity depend on the type of extraction, the social and economic component, the users, and the natural component, the resource.

Use is either consumptive or non-consumptive. Consumptive use is the physical harvest or extraction of the natural resource for the need for food, water, energy, etc. In ecological sense, use of biodiversity is an intentional intervention in a system. It can be regarded as substituting 'predation', bringing a animal population at a level below the theoretical level of carrying capacity of the system in which that species lives while enhancing its reproduction. By extracting their needs from a resource, people also inevitably modify that resource, intentionally or unintentionally.

Sustainable consumptive use of biodiversity means taking the interest of the system's capital within the boundaries of the system's resilience. The concept of Maximum Sustainable Yield (MSY), long in use in population biology, or that of Sustained Yield in forestry, assumes that there is a level of

Consumptive use: timber tree harvesting (Cameroon)

use that a population of wild animals such as antelopes or fish can sustain indefinitely, that the population is not in danger of 'collapse'. Convincing evidence demonstrating the value of this concept is hard to find, partly because the fact that populations are also subject to natural fluctuations, was not taken into account. Various systems of quota setting are applied to the harvest of living resources, whether these are populations of free ranging animal species (mammals such as antelopes and whales but also fish) or Non-Timber Forest Products (NTFPs), all with their specific pro's and con's. North Sea fish populations demonstrate that such approaches are not always successful. The non-linearity of ecological relationships explains this. Thus the harvest should be under this optimal MSY level to safeguard the 'capital' for the future.

The scientific challenge is to design exploitation systems for resources that are 'common', that integrate the conditions for exploitation as set by the resource itself and the exploitation requirements as defined by the users. Current 'harvest' models assume that the e.g. animal populations

under consideration are reasonably stable. I have discussed how flawed the notion of stability is. Similarly, human societies are not stable either. Often attempts to sustain the use of a particular resource do not take other system variables (be it ecological or social) into account and can trigger changes occurring so slowly that they go unnoticed until they trigger an abrupt change. Unsustainable use of environmental resources in combination with bad leadership, short-term political visions and destruction of habitats have driven societies into extinction, as described by Jared Diamond in his book 'Collapse' (15).
So we need new models that couple ecosystem dynamics and thresholds for use with socio-economic drivers. We have to integrate the resilience of ecological systems with the resilience of socio-economic systems. We need suitable indicators to measure performance over time. In this way, optimal or sustainable use will acquire a different meaning to the one we are used to!

Non-consumptive use includes all forms of exploiting ecosystems that does not deliver physical output. Instead they provide services such as information, protection, regulation and enjoyment (2). And as with consumptive use, the challenge exists to come up with exploitation systems that take the characteristics of both the resource and the user into account.

Non-consumptive use: bird watching in Falsterbo (Sweden)

For both consumptive and non-consumptive use one has to be clear about the objectives, as not all types of use are compatible. Wildlife utilization in sub-Saharan Africa is only partially compatible with free-ranging livestock farming, due to the dietary overlap between some wild ungulate species and cattle.

Use always has an economic connotation. The activity needs to result in a product or service that is worth the energy invested in it; it should generate human benefits that are competitive with the returns from other activity options. In this respect there is no difference between commercial game ranching, arable farming, subsistence hunting, fishing or safari tourism, to name a few use types. As the environment changes in space and time it means that when in one region commercial hunting is a profitable business, elsewhere it may be dairy farming or ecotourism (table 1), depending on the categories of users and their exploitation strategies. Consequently, in the exploitation models to be developed a cost-benefit analysis is an integral element.

Table 1: Land-use options in different climate zones, taking social, ecological and financial factors into account (ranking from 1 (= worst) to 10 (= best) according to pooled expert opinion (n=16)) (Grootenhuis & Prins, 2000)

land use	arid zone: rainfall <400 mm	semi-arid zone: rainfall 400-700 mm	humid zone: rainfall 700-1200 mm	montane zone above 2000m: rainfall 700-1200 mm
Safari tourism	10	10	3	6.5
Tourism	9	9	5.5	8.5
Game cropping	7	7	4	4
Pastoralism	8	7	1	2
Livestock ranching	6	7	2	5
Dairy farming	2	2	8	8.5
Rain-fed agriculture	3	5	7	3
Estate cultivation	1	4	10	6.5
Irrigated agriculture	5	3	5.5	1
Forestry	4	1	9	10

In the realm of conservation organizations, sustainable use of wild living resources (consumptive and non-consumptive) was embraced as a tool to protect and sustainably conserve wild populations of plants, animals and

even landscapes. This approach was adopted reluctantly at first but in the end leading to the formulation and endorsement of the Sustainable Use (or Addis Ababa) Principles at the CBD (Kuala Lumpur, 2004). The assumption is that by exploiting a resource and attaching a commercial value to a resource product, this resource would be safe as long as there would be a market for that product. There are hardly any examples from the use of wild living resources that support this assumption. On the contrary, as with quota systems, practice differs from theory. Many examples suggest that the rarer a species is, the higher their commodity value. Standard economic theory predicts that at a certain moment costs outweigh the profit made on the product halting the activity. However, with endangered species, there is apparently a premium for having the last individuals. This effect drives species into extinction (so-called anthropogenic Allee-effect).

Four main causes lead to unsustainable use. The first one is the lack of strict enforcement of such quotas. The second is the absence of legal ownership for wild resources or 'commons'. These common goods require shared responsibility. Generally, there are, however, no clearly defined ownership or rights, and there is always the 'free-rider' problem. Commons theory has moved from the *'tragedy of the commons'* model to small-scale community-based systems as research has revealed that through their capability for self-organization and self-regulation, communities are able to control access of potential users and overcome the problem of excessive use at the expense of others (18). However, such community-based management is vulnerable to external drivers and ineffective on a larger scale such as with migratory resources.

The third cause is the progressive development of harvesting techniques. Whereas earlier techniques resulted in a harvest within the boundaries of resilience, the modern, sophisticated techniques are able to find the last Amur tiger or specific orchid. Again, we need to develop more appropriate exploitation systems that include enforcing the sustainability of resource use.

The issue of equity is the fourth cause that results in unsustainable resource use, even in case the adequate level of resource use is known. It is a social and cultural challenge to come up with a distribution of the useable part of the resource that is acceptable to present-day and future stakeholders. Equitable access to (the benefits of) biodiversity is a condition to its use.

So far my lecture covered the more traditional ways of biodiversity use such as fishing, hunting, collection of NTFPs, ecotourism, medicine, energy, etc. The driving force in that approach is the notion that if we do not manage biodiversity sustainably, it will degrade and disappear. However, we can also look at biodiversity use from a different perspective, by considering it as an opportunity for business with explicit intended direct or indirect benefits for biodiversity.

The private sector has long had its links with biodiversity, since the early days of man as a hunter/gatherer and the emergence of trading of products from natural system use. However, in that relationship biodiversity, until recently, did not receive attention for its own value and as an integral part of that relationship, but only from the perspective of providing goods and services, and with disregard to damage to that biodiversity. In business, biodiversity is self-evident. However, there is the challenge to change that relationship to one that produces biodiversity benefits.

Recently, Shell and the World Conservation Union (IUCN) explored potential business approaches that could influence biodiversity conservation positively and significantly (17). Some of their conclusions are:

- Viable biodiversity business opportunities exist in most regions of the world that are not fully realised
- Capital is not the problem; the bottleneck is finding projects that deliver a reasonable financial return with biodiversity benefits
- Emphasis should be on large-scale market transformation.

Some identified business opportunities are the marketing of biodiversity benefits from activities such as organic farming, sustainable forestry, or carbon sequestration, and the creation of biodiversity banks for offsetting impacts on biodiversity.
This kind of biodiversity use requires a mindset change about biodiversity exploitation and conservation. We need a paradigm shift, as our current models use only financial and economic criteria, new communication mechanisms to make biodiversity business an accepted tool for conservation, and new indicators for measuring its success. Through active partici-

pation in think tanks and various forums, I will contribute to the development of this approach to biodiversity use.

Will these new ways of biodiversity conservation bring success? Perhaps, we have still to overcome many obstacles. By bringing biodiversity use into the (real) economic and financial world through the development of biodiversity business, society has to discuss and agree on the ethical issue of transforming biodiversity from a collective good into a privately owned commodity. This will not be an easy debate.
The biodiversity business I described (if accepted as a useful option to conserve biodiversity) may ultimately be more effective than the 'traditional' exploitation strategy for biodiversity conservation. However, the free-rider problem will remain.

These new ways of natural resource or biodiversity use and its sustainability evokes the discussion whether or not to account for those resources using an economic framework. This is a very interesting topic for discussion, but I will not elaborate on it here.

Users: man as an ecological actor and condition

Mr. Rector Magnificus, in my journey through the world of sustainable use of living resources I have now arrived at those that use these resources. We are all users of biodiversity, directly or indirectly. As there are quite a few research centres in Wageningen University that devote energy in unravelling the social and economic complexity related to those that exploit natural resources, I will highlight one or two aspects that I consider important.

The first one is that of exploitation strategy. The ultimate decision on how and when to use (a certain part of) biodiversity is subject to a complex set of factors. These are factors within the domain of influence of the decision maker himself such as availability of time and technology, position of the outcome relative to other sorts of income, time of the year, etc. Moreover, there are external factors beyond his sphere of influence such as emerging legislation, politics, competition, etc.

The farmer-hunters I met in Mali applied a different decision model with a different optimal harvest outcome than the professional hunter from the same village. They value the resource differently and have different definitions of optimal harvest levels.
The challenge we have is to analyse these decision-making models and translate them into generally applicable guidance for sustainable use.

Fisherman (Kenya)

The goal to use biodiversity sustainably can never be achieved without addressing the issue of poverty. Poor

Bringing bush meat to the market (West Africa)

people will disregard any environmental restrictions in their daily search for food, energy, and shelter. Turning their present use of resource use into a sustainable activity requires an investment that reduces their poverty (19). In large parts of sub-Saharan Africa, agriculture is subsistence farming due to human population growth, lack of produce markets, decreasing field size and degraded (grazing) lands. This farming is insufficient to provide a basic income and people look for other additional activities to increase their income. When rainfall fails, pressure on the land and its resources accelerates. In combination with low prices for agricultural produce, absolute poverty is the result. The smaller the margins of existence, the more sensitive people are to fluctuations in rainfall or market prices. In such situations where the basis for existence is missing, people demonstrate a short-term survival strategy: diversification of activities, high birth rates, high mobility and short life expectancy to name a few characteristics. Exhaustive use of the environment (better to use it now than leave it for tomorrow and find it gone), mobility (get out when possible) and many children (assurance for unemployment and widowhood) are necessary

steps for social and economic reasons. Ecologists call this a r-strategy (r for reproduction). Contrary to this strategy is the K-strategy (K for carrying capacity) where due to guaranteed income over a longer period of time, quality of life is the driving force but at a high cost for the environment (pollution) as well.

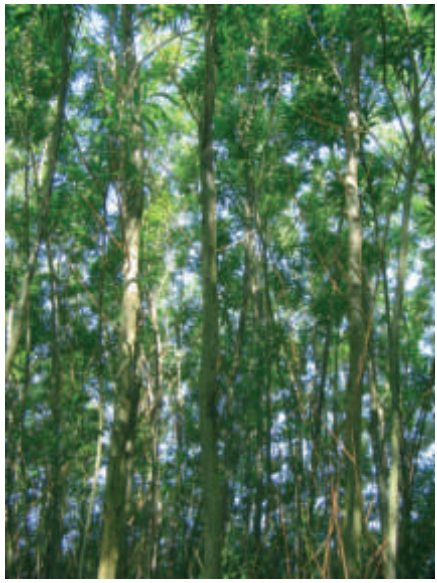
The diversification observed in sub-Saharan Africa is not a positive sign of development but signals the hopelessness of the people's existence. Development projects are income-generating opportunities. Once ended, little remains of the good intentions: targets groups have moved on to new opportunities. Therefore, the many development programmes delivering technical agricultural know-how, machinery and fertilizers have often limited effect and hardly deliver value for money. Through my field work in West Africa I know that farmers and other rural land users are highly effective in getting the best out of their land; there is no non- or underexploited potential! The solution lies much more in providing large-scale alternative economic activities alongside urbanization that provide basic secure income and leads to security of existence than in intensifying current agriculture. Enabling alternative economic development options will break the vicious circle of circle of *poverty » high birth rate » environmental degradation » poverty* and results in reduced pressure on land, the stimulation of urban markets for agricultural products (that then will enable intensifying agriculture) and restoration of degraded areas.

The above is valid not just for Africa but also for other parts of our planet where people are living in poverty. Globally about 4 billion people live at an annual income of less than $1500, the minimum considered for a decent life. Roughly 25% of them live on less than $1 a day! Lifting those people at the bottom of the income pyramid out of poverty is the only option to end social imbalance and to reduce enhanced environmental degradation (20). As with the Africa example, it will divert people from exhaustive exploitation for income!
We need to understand the socio-economic and cultural drivers and governance systems that underlay poverty in order to identify the possible options for sustainable use of biodiversity.

Sustainable use of biodiversity: integrating ecological and socio-economic concepts

Mr. Rector Magnificus, biodiversity use is at the crossroads: Traditionally, we see the use of biodiversity as the harvest of what nature produces. We now need to perceive it as the main determinant of ecosystem services. That requires a mindset change on biodiversity and on its sustainable use. We need to examine the value of existing ecological and socio-economic concepts and models, and develop new ones that account for the complex interactions and different scale levels.
Also, we need to break down the barriers between ecologists, social scientists, economists and other disciplines, and put even more emphasis on integrated research programmes (not integrated research!). And we need to merge basic science with applied science, something already familiar to Wageningen University.

We have to accept that new partners will come in play, on particular the private sector. In the years to come world's energy demand will raise two- to threefold. Meeting that demand forces us to come up with new energy sources and innovative technologies. Biomass in many of its appearances will be part of that answer and will affect biodiversity. The challenge is to find ways of producing biomass-based energy with biodiversity benefits. What about using invasive species such as *Typha* for local generation of 'green' energy? It follows that multi-stakeholder involvement is a critical success factor in finding acceptable solutions. Similar stories relate to bio-prospecting, bio-credits and bio-carbon.



Biomass for bio-energy (Netherlands)

In other words, I see a renewed role for biodiversity use. There are opportunities for using biodiversity that we haven't fully utilised yet! It will require a societal debate on the questions: 'who owns this biodiversity' and 'who is entitled to use it'? This is a part ethical, part philosophical debate.

With new views on biodiversity use and new players, it means finding new ways of communication with partners, focusing on mutual interests and creating value, with new alliances between business, science, societal organizations and governments. Finally, sustainable use of biodiversity requires a change in the enabling environment. New models for the integrated management of resources and users, new business paradigms, new governance systems and new policies. We have to move beyond our comfort zone of established thinking and known research paths!

Research agenda

Ladies and gentlemen, it will be clear to you that the theme 'sustainable use of living resources' is also at the crossroads of several different scientific disciplines. The landscape I see at this crossroads looks vast, with many bushes, open fields, some hidden streams and occasionally slippery slopes, representing the many different aspects, topics, concepts and theories that apply to this theme. Wageningen has in-depth knowledge of some parts of this landscape. Standing on those boulders of knowledge and with my scientific background and experience in science and business, I am able to look beyond the horizon of disciplinary sciences and to identify opportunities for research yet unknown. However, I will follow the saying *"In der Beschränkung zeigt sich der Meister"* and try to limit myself to the following lines of research.

Living resources: my research programme will focus on natural ecosystems, functional species groups and key species to better understand the longer-term dynamics of such systems, including properties such as resilience, recovery potential, and regime shifts. A combination of site-related in-

depth research with focused experiments will help arrive at widely applicable conclusions.

Exploitation systems: I will give attention to the development of exploitation models for sustainable use under different systems of tenure and ownership along with their connected rights and obligations. In particular the application of resilience thinking in both the ecological and social component of exploitation will have my interest.

Indicators for sustainable use: the focus will be on the definition and development of suitable indicators for sustainable use of biodiversity, which can be applied at various spatial scales.

Business and biodiversity: I will contribute to the development of concepts for shaping the relationship between business and biodiversity for better conservation and sustainable use.

Sustainable exploitation of biodiversity has recently regained attention, and it is exciting to notice that both biodiversity and sustainability are described in the domain of this University! Despite this interest, research is often limited to specific subjects and seldom from an integrated (or holistic) point of view as described in this address. Sustainable use of biodiversity requires an interdisciplinary research strategy and this chair will provide input to that strategy where possible.

Education

What does the foregoing mean for education?
Wageningen University is a unique centre of knowledge representing a wide range of subjects, from plant production and animal science, nutrition and genetics to social science and business administration. This provides a unique position to pay multi-disciplinary attention to the sustainable use of biodiversity in the BSc and MSc curricula. For me it is a challenge to add the business perspective of biodiversity conservation and sustainable use to that.

PhD students: with you we will execute the experiments and field studies we have formulated. In fact you are the nucleus of our research and we will invest a lot of time and energy in you, for your benefit to become excellent researchers and generate the quality papers we want!

In my lecture I have highlighted the exciting opportunities for business to contribute to biodiversity conservation and sustainable use of living resources. We need to make the business community aware of this promising activity and equip them with the required knowledge and tools. I am delighted to announce that in collaboration with TIAS Nimbas Business School we are developing a fast track training module for MBA students enabling them to specialize in natural resource management as part of their course.

Academic education is the main objective for any university, training students in critical, scientific thinking. Our students need to be equipped for their role in our future society. They are our future business leaders, civil servants, researchers and professors. Tomorrow in a seminar organized by Unilever, Wageningen University & Research, the Ministry of Agriculture and Shell, and which is also at the occasion of this inaugural lecture, well-known experts will discuss the various aspects of the sustainable production of bio-fuels, an important energy source of the future. In fulfilment of my educational task, I saw it as an obligation to organize and chair a Round Table with the brightest MSC and PhD students from this university to tap their knowledge and ideas on this subject. That Round Table preceded this speech. Not hampered by any tunnel vision and fixed ideas, these students came up with very smart suggestions for the seminar tomorrow. Education as it should be!

Lectureship

Summarizing the above, biodiversity conservation and its sustainable use are now at the crossroads where extensive research is required to inform decisions with far-reaching consequences. So far, the issue of conserva-

tion and sustainable use of biodiversity has, scientifically, been dealt with in numerous single discipline studies. But the subject needs an integrated, multidisciplinary approach at different scales. The challenges are large: integrated analysis and concepts for ecological and social processes, exploitation models combining ecological and social drivers, economic models for natural resource use valuation, and models for the commercialisation of biodiversity, to name a few.

My research on specifically the effects of man-induced interventions in ecosystems seamlessly links with the research on large free-ranging animal assemblages of the Resource Ecology Group that hosts my chair. It will ultimately provide new insights into processes that drive the dynamics and recovery potential of ecosystems, including the role of organisms. Such insights are fundamental and contribute to the knowledge needed to steer restoration processes in degraded ecosystems.

Collaboration with other chair groups in Wageningen University
By now you will understand that scientifically the sustainable use of living resources is as much an ecological discipline as it is a social, organizational, economic, business management and technical discipline. Consequently, there are many interfaces with other groups and departments in Wageningen University. Animal science (e.g. fish culture and fisheries), Environmental sciences (e.g. forest and nature conservation), Plant sciences and Social science to name a few.
Signals in society indicate an increasing interest and demand for analyzing the effects of human activities on biodiversity and its sustainable use. That request focuses on secondary, often longer-term effects in particular. Therefore I expect that our research programme will appear to be an expanding field where collaboration with other groups and departments in Wageningen University is of significant strategic and societal importance, and will produce interesting results.

Already I have my contacts with other institutes and universities in the Netherlands and abroad where sustainable use or sustainability is one of the core research themes. It is my intention to expand this network.

The private sector

From my lecture you may conclude that I am very optimistic on the role business can play in managing and sustainably using biodiversity. Indeed, I see exciting opportunities and I observe companies making the first steps. But I do not close my eyes to the risks. This University, better than any other university, has the expertise that is required to critically follow these new initiatives, support and co-operate where possible, and warn where necessary. The seminar we have tomorrow is a good example of that dual role. Over the years to come I hope to be able to contribute to that process.

In conclusion

This lecture touched upon the interrelationships and connectivity between the various aspects of the sustainable use of biodiversity.

The outlook for conserving and sustainably using biodiversity is nevertheless bleak. Poverty reduction, economic growth and improving health care will ultimately lead to a drop in population growth that is beneficial for biodiversity conservation and opens opportunities for sustainable use. However, it is very likely that this will be not enough to compensate for the impact of higher consumption, energy demands, and related environmental pollution.

We need to find new ways for the conservation and sustainable use of biodiversity and ecosystem services, in order to achieve the ultimate goal of a sustainable society. May this chair help to achieve that!

Word of thanks

Ladies and Gentlemen, the appointment of a professor is partly by personal achievement, partly by the presence of an enabling environment. And the latter is certainly true in case of a honorary professor. Many of you, present here today in this Aula have contributed to this enabling environment for this professorship. Therefore I like to thank you all and say a few words of gratitude to some of you in particular.

Rector Magnificus, members of the Executive Board, and members of the Appointment Committee: I thank you and Wageningen University and Research for the confidence you have in me to occupy this chair. I do my best to make it into a success.

Prof. Dr. Prins, dear Herbert: you kindly offered to host this chair. Your drive for the conservation of biodiversity, and providing that conservation effort with sound ecological research is inspiring. I hope that through my chair I can assist you to unravel some of the scientific enigmas that still puzzle us and of which the outcomes are so important to wise use and at the same time conservation of biological diversity.

This chair Sustainable Use of Living Resources is an honorary chair, financially made possible by the Shell Research Foundation. It is still unusual that a private sector company like Shell considers an issue such as biodiversity so important for their long(er) term core business that the company invests in non-commercially relevant research. Without Peter Kwant this chair would not have been there: from the beginning he was the best advocate one could wish, immediately seeing the value of having a link between biodiversity research and Shell's day-to-day core business. Peter, thank you very much!
I am also much indebted to Royal Dutch Shell plc., in particular to Mr. Jeroen van der Veer and Mrs. Linda Cook, and the Shell Research Foundation; I thank Mr. Lex Holst and Mr. Kieron McFadyen for offering me the time to fulfil the requirements of this chair.
My colleagues in the Operational HSE in Corporate Affairs (Shell International): you have already seen the consequences of this position: I am even less present in the office than I was before. I will do my best to spend a reasonable amount of time in The Hague and try to be a good colleague.

Dear colleagues of Wageningen University and Research centre, the presence of different scientific disciplines and their involvement in research that contributes to sustainable use of biodiversity is a great advantage for my chair. Over the last year I have had several meetings with some of

you that will form the basis for challenging ways of collaboration. It is a privilege to work in your environment.

Dear colleagues in the Resource Ecology Group, you welcomed me with open arms. With some of you I have already started exciting projects. I hope we can expand our collaboration in the near future.

Dear students,
I hope that I have been successful in my attempts to convince you that the theme 'sustainable use of living resources' is a challenging field of science with many opportunities for short-term studies or a life-long career. I look forward to our next series of lectures discussing the different approaches to this intriguing subject of the sustainable use of biodiversity.

Dear friends,
Too many names to mention. Thank you for having been there all those years, for inspiring me and for reminding me that there is another life that is at least as important as work!

Dear family,
A special word of thanks for my mother, Marije and Jasper, and Marijn who unfortunately cannot be present today. Your continuous support means a lot to me.

Dear Nanda,
Some years ago when the situation in my life as well as in my job was far from happy, you entered my life and helped me through! And more than that, since then we share our lives. For your love and inspiration, for bearing the discomfort that my activities bring along and for your support throughout, thank you so much!

Mr. Rector, ladies and gentlemen, I have tried to give you an overview of the fascinating domain of Sustainable Use of Living Resources, an area where theory and practice are closely interwoven.

I hope that some of you may have become inspired through this lecture and I am certain that others will be relieved that the official part is now over.

I thank you for your presence and attention.

I am grateful to Peter Kwant, Herbert Prins, Chris Geerling, Pieter Ketner and Sachin Kapila for their constructive comments on earlier drafts of my lecture, and to Richard Sykes who kindly improved the quality of the English text.

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