

SAPIA NEWS

SOUTHERN AFRICAN PLANT INVADERS ATLAS

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Excellence in Research and Development

WORKING FOR WATER

Inside this issue:

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2011: International Year of Forests

The United Nations General Assembly declared 2011 the **International Year of Forests** to raise awareness of the sustainable management, conservation and sustainable development of all types of forests.

The greatest threats to forests world-wide are unsustainable harvesting of timber, unsound land management practices, conversion to agricultural land and creation of human settlements. Invasive alien plants (IAPs) are also perceived to be a threat, particularly where there has been fragmentation of the forests and disturbance on the margins. However, the pioneer-like, light-demanding IAPs that invade these disturbed sites provide the buffering micro-climate to facilitate natural forest recovery!

This issue of SAPIA News is devoted almost entirely to the very different approach to managing invasive alien plants in forest ecosystems put forward by a leading forest scientist in South Africa, Dr Coert Geldenhuys. He gives some background to forest dynamics in South Africa and how alien plant stand manipulation can be used to speed up the conversion of stands of alien plants to stands of natural forest regrowth.

In the forest environment many invasive alien plant species are nothing more than pioneer species that facilitate the forest recovery process when the disturbances are removed from the system. Light-demanding IAPs cannot threaten natural forest in good condition. In contrast, shade-tolerant IAPs pose a real threat to the integrity of mature forest (C.J. Geldenhuys)

The Weeds and Invasive Plants website: www.agis.agric.za/wip is currently not being managed due to ongoing operational problems at AGIS.

Requests for information from the SAPIA database and submission of records of invasive plants should be sent directly to Lesley Henderson at L.Henderson@sanbi.org.za.

SAPIA newsletters are posted at the ARC website: www.arc.agric.za
under ‘News Articles’.

Most invasive alien plants facilitate natural forest recovery—how is that possible?

Coert J Geldenhuys, Forest Ecologist, Department of Forest & Wood Science, Stellenbosch University

Invasive alien plants (IAPs) are considered one of the threats to forest biodiversity, but I question such statements, from my own observations and research. From discussions with many people, I suggest that we need to develop common criteria for assessment. I define an invader plant in the natural, closed, evergreen forest as one which will increase its numbers and biomass to the detriment of the forest species composition, stand structure and life-support systems, through various processes such as continuous regeneration, prevention and suppression of natural forest regeneration, suppressive growth rate or crown development, and/or upsetting of the natural disturbance regime.

Maybe what we sometimes see as 'shocking levels of alien infestation' are, rather, amazing levels of forest recovery that complement the natural process where indigenous pioneer plants do not fulfill that role adequately. I also want to remove invaders from the forest, but then cost-effectively, i.e. a forest rehabilitated at low cost, with no invasive plants coming back. **How many alien plant control programs rehabilitate the natural vegetation cost-effectively?**

Forest dynamics

The natural, closed, evergreen forest system is long-living with mostly specific development stages (succession) from the disturbed state towards mature forest, in which relative shade-tolerance is the ecological driver. We need to understand where invasive alien species fit into this sequence—which is very different to the grassland, fynbos and karoo systems. Whereas alien plants compete with fynbos and grassland, they can facilitate forest recovery.

It is important to understand the context of natural forests in the landscape, the role of fires to control this location pattern and the consequences for the spread of invasive alien plants when this fire regime is changed or excluded.

Natural forests in South Africa, and many other similar tropical/subtropical landscapes, occur very fragmented in the landscape within a matrix of fire-adapted fynbos, grassland or woodland. Natural forests grow in areas with a minimum rainfall of 500 mm/annum in the all-year and winter rainfall areas and about 700 mm/annum in summer rainfall areas. If rainfall is used to predict the potential area for the presence of natural forest, and 800 mm/annum is used as the lower boundary, then 7% of South Africa could potentially be covered in forest—but only 0.1% has natural forest cover. That huge discrepancy is mainly the result of fires in the landscape, with a very small part attributable to human clearing. Natural forests persist in 'fire-shadow' areas in the landscape, and when they transgress that natural boundary, the woody regrowth gets burnt down. **The abrupt boundaries between forest and other biomes are maintained by wind-driven fires under extreme weather conditions**, particularly hot, dry, gusty and strong bergwinds (**photo 1**). **Human activities have changed those extreme fire regimes** through applying cool, manageable fires in natural areas, implementing fire protection in areas of forestry plantations and agricultural crops, and infrastructure development (roads, housing and settlements). Many plants, particularly woody species, and specifically **alien invasive pioneer-like species become established in that changed environment**, and we call that 'shocking levels of alien infestations'. It is shocking for the fynbos, grassland or woodland, but not for natural forest—if we want to allow fynbos, grassland or woodland to become natural forest.

Photo 1: Fire flows (solid lines) along ridges and jumps (dotted lines) across gullies contribute to the fragmented forest location pattern within grassland in the Cathedral Peak area, KwaZulu-Natal Drakensberg. **Photo 2**: A pine plantation planted in grassland within the fire zone is totally burnt during a bergwind fire and the forest within the 'fire-shadow' valley totally escapes the fire.

The invasion of pioneer-like, light-demanding alien species is the start of the recovery process of natural forest

Natural forest succession

A diverse range of shade-tolerant natural forest species establish in the understorey of the light-demanding alien tree nurse stands (photo **3**—pines (left), Australian blackwood (middle) and eucalypts (right)), and provide a basis for converting such stands to natural forest re-growth through the succession process.

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If we want the natural forest to develop or recover, but we clear the alien plant stands, then we will have to do that continuously because we perpetuate the disturbance and the conditions that facilitate the establishment of the pioneer-like, light-demanding alien species. Species in this category include pines, eucalypts, acacias, bugweed (photo **4**) lantana, chromolaena, guava, inkberry, bramble, and other light-demanding, fast-growing, disturbance-responsive species with easily dispersed seed.

Manipulation of alien plant stands

If the vegetation is neither cut nor cleared and fires are prevented (if in the fire zone), within 10-50 years there will be forest regrowth and the dying out of the alien plants. However, we can manage this process through alien plant stand manipulation (NOT clearing) to speed up the conversion from alien plant domination to natural forest regrowth stands AND a permanent control of these invasive alien species, at little cost.

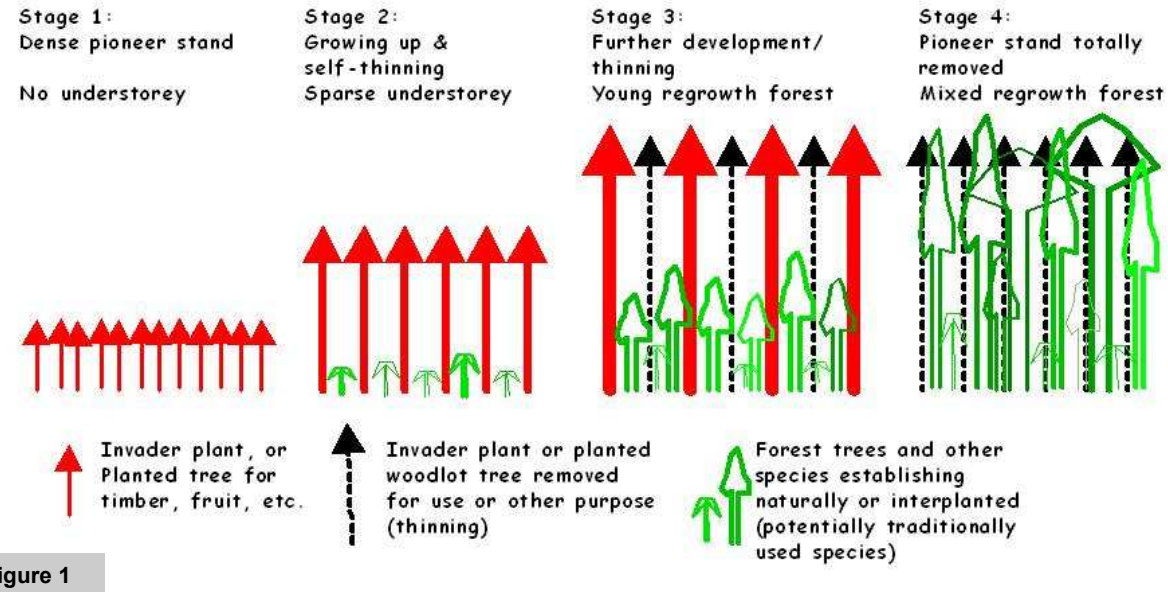

Figure 1

We basically manage the succession process through four stand development stages within a four-step forest rehabilitation action within an area invaded by alien plant species in the forest environment. The rehabilitation is applicable to stands of both natural pioneer and invasive alien plant species.

Manipulation of alien plant stands continued

***Step 1*:** Zone the rehabilitation area broadly in terms of end-points which are to be achieved by alien tree removal: productive farmland, continued timber production, broader riparian zone, narrower stream bank, and different types of natural areas. Differentiate between areas that need abrupt total clearing of alien vegetation (e.g. grassland or shrubland), and areas that need gradual removal of alien stands ('forest' and riparian zones). Not all areas suitable for forest can be converted to forest sustainably—stay within the 'fire shadow' areas, including artificial 'fire-shadow' areas (e.g. built-up environments).

Step 2: Zone 'forest' and riparian rehabilitation sites according to the stand development stages illustrated in **Figure 1 on page 3**, i.e. by species composition and 'age' (size) of alien nurse stands, and by density and height of indigenous woody vegetation in the understorey:

Stage 1: **Dense, young nurse stands**, with none to very few stems of indigenous tree species. Manual stand manipulation needs to be delayed until the stand develops through self-thinning. The stands need to be inspected from time to time.

***Stage 2*: The nurse stand is still relatively dense, but taller**. Forest tree seedlings and saplings (shade-tolerant) and species of other growth forms start to establish in the understorey, sometimes in small clusters, but they develop slowly due to low light conditions. Focus stand manipulation on selective removal of invader plants to facilitate growth of forest tree seedlings into saplings and poles.

Stage 3: **Nurse stand is taller with fewer stems, i.e. natural stand-thinning is in progress** which creates more space and light in the understorey. More forest tree clusters develop and more plants of forest tree species develop from seedlings to saplings to poles to small trees. Focus stand manipulation on removal of all nurse stand plants within and close to clusters to facilitate development and expansion of the cluster.

Stage 4: **Advanced stage of forest recovery, with most or all nurse plant stems removed (or dead).** The forest structure is developing towards a continuous forest canopy with a range of tree stem diameters. More species become established and young stems develop into trees which become part of the canopy. Focus stand manipulation on removal of all invader plants in a gap, or on the forest edge, i.e. a low-key activity that requires occasional inspection to remove alien trees that may establish in gaps.

Step 3*:** Stand manipulation should be implemented in stands of development stages 2 and 3. The intensity of rehabilitation activities will vary according to development stage, defined by canopy and understorey, of each nurse stand. Selective thinning of unwanted trees in the nurse stand, by cutting or ring-barking selected trees, will enable natural regeneration of forest species. ***Five golden rules need to be considered:

1. ***Focus on the establishing forest species clusters*** to facilitate their development and expansion;

2. ***Maintain a relatively closed canopy during selective thinning of nurse trees*** to prevent regeneration and regrowth of the alien nurse species;

3. ***Create growing space for the regeneration and growth of forest species in the understorey*** by removing small, suppressed or stunted sub-canopy stems of the nurse species;

4. ***Keep the ground cover (herbaceous plants, litter, dead branches, etc) intact*** to prevent development of invader plant seedlings;

5. ***Do NOT burn tree debris on the rehabilitation site***; burning will push the recovery process back for several years. The generated heat will a) kill seeds of forest species that may be present in the organic and/or litter layers; b) destroy the soil organic layer and associated micro-organisms involved in the decomposition and nutrient cycling processes (sterilize the soil); and c) stimulate hard-coated seed of some species, particularly invasive acacias, to regenerate in mass.

***Step 4*:** Transplant forest seedlings from seedling clusters on site into spots without tree seedlings. Do this during misty or rainy weather to ensure successful rehabilitation effort.

The results from the various rehabilitation actions according to this approach have shown that a pioneer, planted or naturalized nurse stand can be converted to natural forest, where this is not in the normal fire zone. This even applies to stands of chromolaena, lantana, bugweed or other similar species.

Benefits over the conventional clearing of invasive alien species: it is much **cheaper** because nature does a large part of the job for free—birds and mammals carry forest seeds into the stand; the manipulative 'interference' through selective thinning **speeds up the stand development process**; it provides **options for small business development parallel to the rehabilitation process, over a longer period,** through using removed stems for laths, poles, firewood, timber, and harvesting of medicinal plant crops and other forest species from such stands.

Management of three types of IAPs in forests

Light-demanding invasive alien species such as black wattle (photo **5**) and lantana (photo **6**) cannot threaten natural forest in good condition.

Clear them and you will get them back 100-fold for all your effort; allow them to assist you and you will gain a diverse regrowing forest with much less effort! It is a different system, a different time frame, a different mindset and a different approach, with many hidden values to the owner of the land, and adjacent communities in many areas, and society as a whole. **The preceding pages on alien stand manipulation apply to these species**

Two other types of invasive alien plant species in natural forests require a totally different approach for removal:

Shade-tolerant invasive species within the forest stand pose a real threat to the integrity of mature forest, such as the camphor tree (*Cinnamomum camphora*) (photo **7**) and sub-canopy and understorey trees such as sweet pittosporum (*Pittosporum undulatum*) (photo **8**), and different privets (e.g. Chinese privet (*Ligustrum sinense*) (photo **9**)).

They have fleshy, bird-dispersed seed. In general, they have a very confined, patchy occurrence in the natural forest. **The best strategy is to remove the seed-bearing trees inside or close to the forest**, and to monitor such areas to prevent the seedlings from becoming dense and suppressive, or to grow into future seed-bearing trees. Fortunately, most shade-tolerant species, native or alien, grow relatively slowly under the forest canopy.

Climbers are a common feature of natural forest on disturbed sites, fertile sites and warmer habitats, and they are light-demanding plants—that is why they climb to the top, and why many have wind-dispersed seeds. Similarly, climbing invasive alien species are generally light-demanding and generally associated with degraded forest, forest gaps and forest margins.

They behave very similar to indigenous forest climbers and fulfill the same function as pioneer trees, but they persist longer on top of the tree crowns, or in sites more regularly disturbed such as on steep slopes. **Their aggression decreases with canopy closure and their stems could be cut at ground level under the canopy**—be careful not to cut indigenous climbers. This is where invasive tree species are useful—they grow too fast for the herbaceous climbers and shade them out.

The spiny and succulent climbing pereskia (*Pereskia aculeata*) (photos **10** & **11**) poses a specific problem. Currently its distribution is still very patchy in disjunct localities. The plant climbs up the stem of a tree, forming dense tangles that drape over and smother the tree crown. The best current approach is to cut the stems hanging to the ground as high up as possible above ground level. This causes the crown tangles to wither and die—but that can take some time. All cut stems at ground level continue to grow and need to be sprayed with suitable herbicide. Stem pieces rooted in the ground sprout aggressively and those lying on the ground develop roots and sprouts. All cut stems and branches should be accumulated into small piles in forest gaps and burnt once relatively dry. In forests where a patch is heavily infested and where the crowns are difficult to access, it may even be better to cut and burn the entire infested patch, including the indigenous trees. The clearing can then be rehabilitated through bugweed which will establish rapidly, or a specifically planted patch of eucalypts that could be used for its poles, or useful indigenous pioneer trees, to manage forest regrowth through succession as described in the preceding pages.

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More invasive alien plants in forest

Shade-tolerant species with fleshy fruits—bird-dispersed: Coral bush (*Ardisia crenata*) (photo **12**), ginger lilies e.g. yellow ginger lily (*Hedychium flavescens*) (photo **13**), loquat (*Eriobotrya japonica*) (photo **14**), purple cestrum (*Cestrum elegans*) (photo **15**), Australian cabbage tree (*Schefflera actinophylla*) (photo **16**)

Other shade-tolerant species: Polka-dot plant (*Hypoestes phyllostachya*) (photo **17**), spiderwort (*Tradescantia fluminensis*) (photo **18**) (reproduces from fragmented stems), Australian tree fern (*Cyathea cooperi*) (photo **19**) and sword fern (*Nephrolepis cordifolia*) (photo **20**)


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Climbers: Madeira vine (*Anredera cordifolia*) (photo **21**) (reproduces from aerial tubers), Japanese honeysuckle (*Lonicera japonica*) (photo **22**) (fleshy fruit, bird-dispersed), cat's claw creeper (*Macfadyena unguis-cati*) (photo **23**) (reproduces from wind-dispersed seed)

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The Weeds Research Programme of the ARC-Plant Protection Research Institute is responsible for research on the ecology and control of invasive alien plants in South Africa. These plants were introduced either intentionally (e.g. for ornamental use or agroforestry purposes), or accidentally (e.g. in livestock feed) and now threaten biodiversity and agriculture. In addition, they reduce run-off from water catchments, thus diminishing flow in streams, and adversely affect the quality of life of communities.

- Biological control
- Chemical control
- Bioherbicides
- Integrated control
- Monitoring the emergence and spread of invasive alien plants

We are on the Web:

www.arc.agric.za

see Plant Protection News

for current news from the Weeds Research Programme

Read *Plant Protection News* No. 86 for the following news from the Weeds Research Programme:

- Lantana flower gall mite: established and spreading in South Africa; exported to Australia
- Herbicides as a tool in managing parthenium
- New biological control agent released against cat's claw creeper, *Macfadyena unguis-cati*
- Stem-galling wasp, *Tetramesa romana*, a host-specific natural enemy of the invasive giant reed, *Arundo donax*, found to be widespread and parasitized in South Africa

Biological control of invasive plants

Cat's claw creeper (*Macfadyena unguis-cati*) showing chlorosis of the leaves caused by the **leaf-feeding tingid (*Carvalhotingis visenda*)**. Photos: A. King

Biological weed control is the use of natural enemies to reduce the vigour or reproductive potential of an invasive alien plant. The principle is that plants often become invasive when they are introduced to a new region without any of their natural enemies. The alien plants therefore gain a competitive advantage over the indigenous vegetation, because all indigenous plants have their own natural enemies that feed on them or cause them to develop diseases. Biological control is an attempt to introduce the alien plant's natural enemies to its new habitat, with the assumption that these natural enemies will remove the plant's competitive advantage until its vigour is reduced to a level comparable to that of the natural vegetation. Natural enemies that are used for biological control are called biocontrol agents.

The potential risk posed by a candidate biocontrol agent is determined by biocontrol researchers through extensive host range studies (specificity tests) that are carried out in a quarantine facility. These trials determine the range of plants that a potential biocontrol agent is able to use as host plants throughout its life cycle, as well as its host plant preferences. Permission to release a biocontrol agent will be sought only if the host-specificity tests prove without doubt that the potential agent is sufficiently host-specific for release in this country. To be regarded as sufficiently host-specific, the candidate agent must be either monophagous (i.e. the insect feeds on only one plant species, the target weed in this case) or it could have a slightly wider host range, provided that none of the additional host plants occur in South Africa or surrounding countries, either as indigenous or introduced crop plants.

South Africa is regarded as one of the world leaders in the field of biological control of invasive alien plants. Since the 1930s we have brought 29 invasive alien plant species under complete or substantial biological control. In the process, 111 species or biotypes of natural enemies were released, 85 of which became established. Remarkable successes have been achieved with either controlling or reducing the invasive potential of many invasive plants including cacti, aquatic weeds, Australian wattles, chromolaena and lantana. Seed feeders feature strongly in many of our projects. Tested and safe biocontrol agents are distributed in co-operation with the *Working for Water* Programme of the Department of Water Affairs.