



TANZANIA NATIONAL PARKS

GUIDELINES FOR INVASIVE ALIEN SPECIES MANAGEMENT

Tanzania National Parks

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Arusha

Tanzania

October, 2017

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**Guidelines for Invasive Alien Species Management in Tanzania National
Parks**

THE ARUSHA MANIFESTO

Over fifty years ago

The First President of the United Republic of Tanzania, the late Mwalimu Julius K. Nyerere recognized the integral part wildlife plays in this country. On September 1961, at a Symposium on the Conservation of Nature and Natural Resources, he gave a speech that laid a foundation for conservation in post-independence Tanzania. The extract of that speech has become known as

the Arusha Manifesto.

“The survival of our wildlife is a matter of grave concern to all of us in Africa. These wild creatures amid places they inhabit are not only important as a source of wonder and inspiration but are an integral part of our natural resources and our future livelihood and well being.

In accepting the trusteeship of our wildlife we solemnly declare that
we

Will do everything in our power to make sure that our children’s
grandchildren
will be able to enjoy this rich and precious inheritance.

The conservation of wildlife and wild places calls for specialist
knowledge, trained manpower, and money, and we look
to other nations to cooperate with us in this
important task - the success or failure
of which not only affects the
continent of Africa but
the rest of the world
as well”

Foreword

Tanzania is blessed with a variety of un-trampled ecosystems, habitats and landscapes, many of which are found in national parks. The continued integrity of these areas is crucial for conservation. However, in the last few decades, it has been observed that rapid spread and emergence of Invasive Alien Species is threatening their ecological integrity.

Invasive Alien Species, a growing environmental and economic threat, is defined as harmful alien species whose introduction or spread threatens the environment, the economy, or society, including human health. Once established, invasive species are extremely difficult and costly to control and eradicate and their ecological effects are often irreversible. If not managed, their impacts can extend to irreparable impairment of ecological systems.

What makes Invasive Alien Species a problem, be it plants or animals, is their behaviour of rapid multiplication, spread and displacement of indigenous species, once they are introduced outside their normal geographical regions. Alteration of ecosystem functions and processes, disturbance in ecosystem regimes, health risks to wildlife, park employees and visitors can also occur. These impacts can be very costly ecologically and socio-economically.

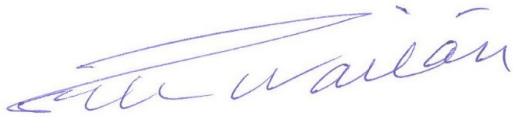
Most Invasive Alien Species in parks are introduced unintentionally, mostly at a time when their negative impacts are not well known. Regardless of their manner of introduction, the management of Invasive Alien Species is crucial to the integrity of protected areas.

Tanzania National Parks has prepared these Guidelines with the overarching aim of standardizing efforts, minimizing costs, risks posed and reducing negative impacts caused by Invasive Alien Species in the parks. The Guidelines focus on the sustainable control and eradication of Invasive Alien Species in parks through enhancing understanding, timely response, monitoring and management. The issue of communication, education and public awareness to all stakeholders with regard to Invasive Alien Species factors leading to bio-invasions and their impacts is emphasized, as well as preventive measures and early detection. Proper and timely decision on the issue of Invasive Alien Species is required urgently, to preserve the integrity of our ecosystems.

Allan J. H. Kijazi
Director General
TANZANIA NATIONAL PARKS

APPROVAL PAGE

The appointed Officers of Tanzania National Parks and its Board of Trustees
have approved the implementation of these Guidelines.



General (Retd) George M. Waitara
Chairman, Board of Trustees
Tanzania National Parks



Allan J. H. Kijazi
Director General
Tanzania National Parks

Date: 19th October, 2017

Abbreviations and Acronyms

CSP	Corporate Strategic Plan
EIA	Environmental Impact Assessment
GMP	General Management Plan
IAS	Invasive Alien Species
NEPAD	New Partnerships for Africa's Development
PA	Protected Areas
TANAPA	Tanzania National Parks
TPRI	Tropical Pesticides Research Institute

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Executive Summary

Invasive Alien Species are invading our national parks, causing tremendous damage to our resources, and thus increasingly threatening the structure, organization, function, and overall integrity of the natural ecosystems we aspire to protect. In addition the Invasive Alien Species impacts include biological characteristics that pose health risks to wildlife, park personnel and guests. The information available shows a serious situation regarding plant invasions that prevails in many areas and the vulnerability of natural or undisturbed areas to the invasions of Invasive Alien Species.

With a primary mandate being conservation of biodiversity, requirement for biodiversity monitoring is clearly specified in national and international legislation and policy as well as Tanzania National Parks policy and guiding principles. Although the potential threats posed by Invasive Alien Species are widely appreciated, the state of awareness, knowledge and level of management of Invasive Alien Species differs considerably among national parks.

In order to deal with this challenge in national parks, this document outlines the background and reasons for monitoring Invasive Alien Species. It has a set of necessary statements outlined in this document for prevention, early detection, criteria for priority control species, effective control and or eradication of Invasive Alien Species. The effective control will be achieved through mechanical/physical, chemical, biological, cultural, indirect and integrated methods. Then, restoration of degraded ecosystems will be pursued depending on the resulted situation. Implementation of these guidelines will promote wise use of available scarce resources, proper control of the Invasive Alien Species and enhance the conservation of the protected areas ecosystems.

As the Invasive Alien Species threats become more widely and severe, increased and enhanced levels of collaboration between local and international partners need to be improved for appropriate reaction and effectively integrate control actions.

1.0 Introduction

1.1 Background Information

Invasive Alien Species (IAS) often cause special problems in protected areas including national parks because they suppress and sometimes replace native or indigenous species hence negatively affect biodiversity. Their effects may extend to significant changes in the structure and natural or normal functioning of the ecosystem of the area that has been invaded (Strayer, 2012). However, there are positive contribution of alien species to ecosystem function and integrity including provision of food, shelter or habitat to other organisms. Invasive alien animals may disrupt native trophic levels (herbivory, predation, parasitism) and other biological interactions such as pollination and competition which can lead to significant environmental and economic impacts (Kenis et al., 2008; vanRensburg et al., 2011).

In Tanzania, human encroachment and disturbances including habitat fragmentation are rapidly escalating, thus opening new opportunities for the introduction and establishment of problem alien species. Increasing human movements is also contributing to this problem. Furthermore, climate change creates conditions that favor introduction and establishment of IAS.

Over the years Tanzania National Parks (TANAPA) has experienced problems with IAS in certain parks. TANAPA has been taking various actions to deal with IAS which sometimes were not successful due to lack of proper guidelines. Therefore, these guidelines will enable TANAPA to make proper decisions and strategies on managing IAS, including prevention, detection and control/eradication for particular species provided that the actions taken are desirable, feasible and acceptable. The guidelines should also enable the parks to prepare IAS control management plans.

1.2 Definition of common terms

1.2.1 Alien species

Are those species that enter ecosystems beyond their historic range, including organisms transferred from one country to another. Alien species, however may be injurious and cause or have the potential to cause harm to native species or ecosystems through processes including hybridization, predation, parasitism, pathology and competition, and potentially harmful to the human interest including aesthetics, economics and health.

1.2.2 Indigenous species

Are those which occur, or have historically occurred naturally in a free state within the national parks. It should be noted that indigenous species may become invasive depending on certain situations for example in case of overgrazing and frequent fires.

1.2.3 Invasive species

Are those whose establishment and spread out of their natural distribution range and have demonstrable potential threats to ecosystems, habitats, or other species and/or may result in economic, human health or environmental harm.

1.2.4 Invasive Alien Species

Are those species that increase their population rapidly displacing or eliminating other species as they do so. Therefore not all alien species become invasive species. Alien species are introduced into new areas either deliberately as source of forage, fiber medicine, ornamentals, erosion control and timber plants or accidentally through vehicles, impure crop seeds, adhesion to domestic animals and soil surrounding roots of nursery crops.

1.3 Scope of the guidelines

The scope of this document is to develop a long-term management guidelines and procedures that would reduce the impacts of (or threats

from) IAS to native species communities and other natural and cultural resources within Tanzanian national parks.

These guidelines are intended to serve as long term guidance for all invasive species management activities. Therefore, the approach is general enough to address management actions without becoming too restrictive by providing park managers with multiple treatment options and allowing them to select the most appropriate treatment option or combination of treatment options included in this document to minimize negative impacts and maximize overall management success. It is also flexible enough to allow for future use of treatment actions that are not currently available or used by park managers. However, the document is specific enough to guide park and species-specific planning considerations.

1.4 Types and characteristics of alien species in national parks

1.4.1 Plants

The alien plants species are categorized in different life forms including Forbs, Succulents, Herbaceous, Shrubs and Trees.

1.4.2 Animals

The alien animal species are categorized in different broad groups including Invertebrates, Amphibians, Fish, Reptiles, Birds and Mammals.

1.4.3. Characteristics of IAS

Some of the characteristics of IAS include; fast self-replication and rapid spreading, response quickly and profusely against control efforts, lag time are common before adverse effects are seen, alter and respond to community interaction in complex ways.

The IAS that have been identified in the national parks are listed in Appendix 1.

1.5 Sources of IAS

IAS are introduced in the parks via unintentional and intentional means. Unintentional or accidental introductions are associated with the trade, transportation and travel by humans. For example, IAS may be carried in or on vehicles, equipment, construction materials (Morrum and sand) or packing materials or as contamination within the cargo itself (Richardson *et al.*, 2003; Ruiz and Carlton, 2003). Seeds and plant parts may be brought into the parks by wildlife, livestock, wind, water and humans. Fast-growing non-native plants can also encroach from populations established outside park boundaries. Once inside park boundaries, the most aggressive of these non-natives spread quickly into undisturbed as well as disturbed areas.

Intentional introduction include plants introduced for agriculture, forestry and biofuel production, plants introduced for soil improvements or erosion control, introduced ornamental plants (horticulture), birds and mammals released for hunting purposes. It also includes animals released as a food resources (farmed animals, fishery releasing, aquaculture, and mariculture), pets and aquarium animals released into the wild and organisms introduced for biological control.

Most of Tanzania Protected Areas (PAs) were previously habituated by local people and planted with some alien species (Drummond and Mollel, 2000).

1.6 Impacts of IAS

IAS can have significant environmental and socio-economic impacts at the genetic, species, population and community levels, and also alter ecosystem functions and processes. Conditions can rapidly deteriorate when one species facilitates and accelerates invasions by others.

Negative impacts of alien species on biodiversity at the community and population levels include; predation, parasitism and diseases, resources competition and reduced recruitment (altered succession), competition for pollinators, seed dispersers and other mutualists (De Poorter *et al.*, 2007; GISP 2006, 2008). Other negative impacts are population reductions and

eliminations, alteration in community composition and vegetation structure, vector pathogens and pests, and other IAS hybridization with native species. At the ecosystem level impacts include alterations in disturbance regimes (e.g. fire, hydrology); geomorphologic processes (erosion, sedimentation); soil chemistry (nutrients, nutrient cycles and pH).

Furthermore, some IAS have biological characteristics that pose health risks to wildlife, park employees and visitors, for example *Parthenium hysterophorus* (McCannachie, 2010) and *Calotropis procera* (deLima *et al.*, 2011).

Management costs of IAS include not only costs of prevention, control and mitigation, but also indirect costs due to impact on ecological services. Usually IAS eliminate the population of indigenous plant species as well as forage for animals and hence loss of biodiversity.

Economies and public health may be harmed by IAS which can clog waterways and ponds, decrease agricultural and timber products, depress tourism and spread diseases to people, domestic animals and cultivated species (McNeely, 2000; Naylor, 2000).

2.0 Challenges on IAS control

Resources available for IAS management in the PAs are, in most cases, inadequate to implement actions that are deemed necessary to reduce the abundance and density of invasive species and manage their impacts. This is partly due to other priorities being placed on the limited resources available for PAs management in general and due to lack of awareness on the relevance of IAS management in the PAs. Science based planning can help to make the best use of available resources.

Another challenge is the range in sizes (small to large), morphological features of parks; island to mountain parks all of which provide opportunities for comparative work across multiple scales. These attributes can provide opportunities for identifying general determinants of invasions in relatively undisturbed environments. The management approach of parks reflect different scenarios, for instance some parks have well studied invasive species like *Senna spectabilis* with well-developed control measures, while others don't.

Inadequate capacity at parks level affects IAS management effectiveness through lack of knowledge, resources and information. It also includes lack of understanding of the importance of carrying out prevention, early detection and rapid response. In order to effectively control the IAS, it is inevitable to understand characteristics of alien species and establish appropriate control methods. It is also important to understand time of their introduction, spread and impacts on other species.

Although wildlife managers recognize the growing threat of alien species, decision makers and the general public still seem to underestimate the problem. Where politicians or decision makers and community are not aware of the magnitude of IAS problems, then it may be unlikely to get sufficient support to address it.

The challenge on the control of the IAS is as well complicated because IAS introduction and spread are externally driven by factors such as increasing human mobility, encroachment of protected areas and climate change.

3.0 Problem statement and justification

IAS poses a significant and growing threat to the economy and natural environment. These IAS have become one of the most pressing conservation issues and have been recognized by many agencies as being one of the greatest threats to biodiversity conservation, second only to habitat degradation and fragmentation.

Invasive species are spreading around the world at an accelerating rate (Mack 2003; Ruiz & Carlton, 2003). Rapid increase in global trade and travel are enabling more animals, plants and disease agents to be transported from their native environment into new territories. The successful prevention and management is an integral part of protected areas management effectiveness (Goodman, 2003; Pomeroy *et al.*, 2004). Environmental and socio-economic impacts of harmful invasive alien plant species are already being felt in some of our national parks. This problem has recently become a matter of concern in most parks.

Therefore, it is of utmost importance to have the guidelines in order to perform the IAS control and prevention activities in a proper manner so as to reduce the ad hoc invasive control activities. It is expected that once the proper control activities are conducted the costs will be reduced and there will be improvement in the natural habitats and ecosystems.

As PA managers/conservationists it is important to be aware of invasive species that threaten ecosystems; learn which invasive species may be present in the environment and how to identify them. Surveys along park boundaries, campsites, lodges, roads and trails for early detection of an infestation should be conducted regularly. If an invasive species is spotted with only few plants present, it is much more cost effective and efficient to control. However, if an existing infestation is too large, developing a monitoring and control plan for the areas will help to determine the best use of time and resources.

4.0 Legal and Policy framework

In Tanzania there are various national laws, policies and regulations related to environmental and protected areas management. International agreements and treaties on IAS have also been formulated. All these recognize explicitly the need for alien species control.

4.1 Environmental Management Act, 2004

The Environmental Management Act, 2004, Section 67, sub-section 2 (h) prescribes prevention of the introduction, control or eradication of alien species which threaten ecosystems, habitats or species.

4.2 National Environmental Policy, 1997

Chapter 3, Section 59 (d) on forestry, states that natural forests with biological value and genetic resources shall be conserved; account will be taken of the danger of monoculture and to the extent possible natural forests will not be replaced by alien species.

4.3 Wildlife Policy 1998

Section 3.3.3 (vii) provides for “regulating the importation of exotic species and re-introduction of a species known to be indigenous to the area in order to safeguard against negative effects resulting from their introduction and reintroduction into the wild”.

4.4 The National Policies for Tanzania National Parks, 2011

Section 3.7, subsection 3.7.7 defines what exotic species are and prohibits introduction of new exotic species. It provides for control including eradication of exotic species wherever such species threaten/impacts on park resources or public health and when control is feasible.

4.5 TANAPA Corporate Strategic Plan (CSP) (2013-2018)

Target 1.1.6 provides for invasive species management guidelines preparation and implementation.

4.6 General Management Plans (GMPs)

The impacts of exotic species and the need for their control are recognized in the parks' General Management Plans. For example, in the ecosystem management programme of Ruaha National Park GMP Target 1.1.3 states "impacts of alien species on parks' resources minimized through actions including prevention of introduction, identification and elimination of exotic species".

4.7 The New Partnerships for Africa's Development (NEPAD)

Tanzania is a member of NEPAD, which recognizes that IAS have already had major impacts elsewhere in Africa and will affect the degree of success achieved by the program through their effects on agriculture, biodiversity, trade, tourism, transport and natural resources.

5.0 IAS control guidelines/statements

Before using any approach in IAS control, experiments are inevitable. Preventing the introduction and spread of IAS in protected areas is a vital element of management. Existing laws can be used. Personnel need to be in place to identify problems and enforce laws. The best control options depends on a number of factors including; knowledge of the potential damage of IAS, relative abundance of the IAS, cost of control method, environmental impact of the IAS and control options.

5.1 Prevent introduction of IAS

It is widely agreed that prevention is better than cure, therefore preventing entry of IAS, or alien species that are likely to become invasive, is more effective than attempting to manage them once they have arrived. Preventing or reducing the likelihood of future IAS infestation establishment is emphasized.

5.1.1 Prevent new invasion and the spread of established invaders by cleaning all camping equipment and gear, vehicles, boats, boots and clothing prior to entry into the parks.

5.1.2 Locate trails and access roads away from known infestation of IAS

5.1.3 Prohibit the introductions of IAS for recreation purposes and planting around visitors facilities and staff quarters.

5.1.4 Address the risk of unintentional introduction associated with construction materials and transit goods.

5.1.5 Determine whether or not a particular species is an alien invasive to the park because the list of IAS (Appendix 1) is not exhaustive.

5.1.6 Conduct regular survey to detect the establishment and or spread of IAS.

5.1.7 Identify and map sites and or habitats/ecosystems and native species that are vulnerable to IAS and map pathways that are frequently disturbed

or visited by tourists like gravel pits, road sides, trails, walkways, picnic sites and viewpoints.

5.1.8 Monitor IAS around vulnerable points of entry like park gates, public roads, tourist facilities, airstrips, rivers originating from outside the park and park boundary bordering villages.

5.1.9 Put in place appropriate fine, penalties or other sanctions to apply to those responsible for introductions through negligence and bad practices.

5.1.10 Assess and monitor engineering projects such as infrastructure (like roads and building construction) that disturb local biological diversity and can be point of introduction of IAS.

5.1.11 Review Environmental Impact Assessment (EIA) of such projects for the risks of associated introduction of IAS.

5.1.12 Prepare action plan for rapid and effective IAS management.

5.1.13 Avoid and minimize ecosystem (habitat) disturbance as IAS will readily invade disturbed places and fragmented landscapes than stable natural ecosystem.

5.1.14 Handle and manage food remains especially fruits so as to prevent seed dispersal in the environment.

5.2 Early detection

Surveillance should be conducted within all areas in the parks for early detection of IAS.

5.3 Mechanical/physical control

This is about using hands and/or tools to remove IAS. This is effective when the population size of invader is small and the population have limited or no means of vegetative propagation. Attempting to eradicate IAS is more likely to succeed if control measures are undertaken at an earlier stage.

5.3.1 IAS can be removed mechanically including use of machines like bulldozers, hand picking, uprooting, cutting, girdling, bark stripping, soil tillage, shooting and trapping to control them.

5.3.2 Proper disposal of removed IAS material is critical to the control process to prevent new infestations or re-infestations. This may involve burning, piling, burying, composting and drying.

5.4 Chemical control

This entails applying herbicides according to label requirements to kill invasive species.

5.4.1 Only chemicals approved by Tropical Pesticides Research Institute (TPRI) should be used for IAS management.

5.4.2 Chemicals used for IAS control in the parks must have very low toxicity to wildlife, and particular care must be taken to prevent harm to the environment.

5.4.3 If many species are being controlled in the same area it is quite likely that the optimum herbicide for each species will not be the same; so to avoid great complexity a small number of herbicides may be desirable, accepting slightly lower mortality rates.

5.4.4 Chemical application methods used include but not limited to application to cut stumps, foliar application, stem injection and bark painting.

5.4.5 Selection of appropriate herbicides should depend on targeted IAS, other plants on site, environmental considerations and meeting management objectives.

5.4.6 Chemical control should be done at the appropriate season to ensure chemical effectiveness and avoid environmental contamination, for example, dry season works better than rainy season.

5.5 Biological control

Biological control is a technique centred on the purposeful use of a living organism - predator with the aim of controlling IAS. To achieve control one needs a biological control agent which could be a parasite, pathogen, predator, herbivore insect, antagonist or a competitor.

5.5.1 Use a deliberate introduction of insects, mammals, or pathogens to kill IAS.

5.5.2 It should include the use of sterile organisms to prevent the reproduction of terrestrial and or aquatic IAS.

However, since TANAPA policy is against introduction of alien species in its parks in the first place, this approach should be used as a last resort having explored all the alternatives or as a national driven project like the red locust control.

5.6 Cultural control

Cultural control means action taken that requires change in human behavior or thought processes.

5.6.1 Use deliberate fires to control some IAS. However, this approach should be used concurrently with vegetation monitoring to determine if there is change in species composition.

5.7 Indirect control (community succession)

5.7.1 Leave the area alone depending on the ecosystem. Different variations of the community succession can be used as technique to eliminate IAS. Over the years native plants will come to dominate and influence the rate and nature of succession.

5.7.2 Promote old field succession in forested areas by planting with native cover plants.

5.8 Integrated control

Integrated methods involve a combination of at least two of the primary elements of control like mechanical, chemical and biological. It reduces dependency on one or few techniques to manage IAS thereby lessening any repetitive and cumulative adverse impacts to the ecosystem. It provides opportunities for selection and tailoring of individual or combined treatments of IAS and thus should be most effective in managing most infestations.

5.8.1 The approach considers type of IAS identified, the magnitude of infestation, features of invaded system, difficulties in control and availability of resources.

5.9 Determine IAS characteristic uniqueness

5.9.1 The prescriptive approach to the management of each IAS should be specific to that species.

5.10 Select species for cost benefit assessment

5.10.1 Assessment should be carried out to determine whether IAS fills an unused habitat, has aesthetic value or provide added food for obviously important native species and functions in the ecosystem. In this way management decisions to control a known IAS would not be made.

5.10.2 To avoid guideline 5.10.1 being controversial a special status report need to be prepared for such species examining the pros and cons of the particular case using both the ecosystem and human based values.

5.11 Set priorities

5.11.1 Prioritizing the list of specific IAS for management action is an essential element of control or eradication. The criteria of selection include biodiversity threats, duration of establishment, side effects of control and the feasibility of achieving and maintaining control. Highest priority would be accorded for control of an IAS which extremely threatens the extinction of native species or ecosystem and for which acceptable control methods exist.

5.12 Control and manage established problem species

5.12.1 Control high priority IAS in high priority places.

5.12.2 Look for alternative approaches if any, in order to have an effective control exercise.

5.12.3 Control should be done earlier before seed production.

5.13 Pursue restoration

The idea behind this guideline is to get native species to replace existing IAS. It is deliberate planting and nurturing of native species

5.13.1 Restore or rehabilitate native species and communities in high priority places.

5.13.2 Use only soils and plants free of IAS for restoration, erosion control, forestry, etc.

5.13.3 Restoration should take advantage of a number of innate characteristics of plant communities, particularly canopied forest (shade tolerant trees, shrubs or herbs). As widely known shade intolerant trees, shrubs or herbs will not survive in areas where canopied forest is the dominant ecosystem.

5.13.4 In some cases chemical control may leave the area bare, therefore it is important to re-vegetate the area with native species.

5.14 Develop educational initiatives on value/ethics

5.14.1 Establish program to assess and disseminate information regarding the effectiveness of ecological restoration as a means of IAS control in the national parks.

5.14.2 Public education and outreach regarding clean equipment, not dumping soil, pets, or other materials in the park in order to prevent introduction of IAS.

5.14.3 Domestic animals and crops will be prohibited in the parks and controlled where they have established in line with TANAPA legal framework.

5.15 Learn the necessity of living with it – at least for now

5.15.1 When the species seems to be essentially impossible to control, it is recommended that control strategies for the species be developed by finding out what approaches have or are being used and consultation for coming up with new control strategy pending new development/ technologies.

5.15.2 It is pointless to continue to be seriously concerned with alien species that are relatively advantageous to their new homes.

6.0 References to consult in IAS management

- De Poorter, M., Pagad, S. & Ullah, M.I. (2007) Invasive alien species and Protected Areas: A scoping report. <http://www.issg.org/Animal%20Imports%20Webpage/Electronic%20References/IASinPAS.pdf>. Accessed on 17/02/2017.
- deLima J.M., deFreitas F.C.J, Amorim, R.N.L., Camara, A.C.L. Basista, J.S. & Soto-Blanco, B (2001) Clinical and pathological effects of Calotropis procera exposure in sheep and rats. *Toxicon*, 57(1): 183-185. Doi:10.1016/j.toxicon2010.11.007
- Drummond R.D. & Mollé, E. (2000) Trees of Southern Africa. Kyodo printing company-Singapore-Pte Limited.
- Global Invasive Species Programme (GISP) (2006) Invasive Species and Poverty: Exploring the links. Accessed on 17/02/2016: <http://www.gisp.org/publications/brochures/index.asp>
- Global Invasive Species Programme (GISP) (2008) CBD COP-0 Invasive Alien Species discussion paper. Accessed on 17/02/2016: <http://www.gisp.org/publications/briefing/GISP%20COP9%20policy%20brief%20051408%20A4.pdf>
- Goodman, P.S. (2003) Assessing management effectiveness and setting priorities in Protected Areas in KwaZulu-Natal. *BioScience* 53(9): 843-850.
- Kenis, M. Auger-Rozenberg, M., Roques, A., Timms, L., Pere, C. Cock, M.J.W., Settele, J., Augustin, S. & Lopez-Vaamonde C. (2008) Ecological effects of invasive alien insects. *Journal Biological Invasions*, 11(1): 21–45. doi:10.1007/978-1-4020-9680-8_3
- Mack, R.N. (2003) Global plant dispersal, naturalization and invasion: Pathways, modes, and circumstances. In: Ruiz, G.M. and Carlton (eds.) 2003. *Invasive Species: Vectors and management strategies*. Island Press, Washington.
- McCannachie, A.J. (2010) Current and potential geographical distribution of invasive plant *Parthenium hysterophorus* (Asteraceae) in Eastern and Southern Africa.

- McNeely, J.A. (2000) The future of alien invasive species: changing social views. In: Mooney, H.A. and Hobbs, R.J. (eds). 2000. *Invasive Species in a Changing World*. Island Press, Washington, D.C.
- Naylor, R.L. (2000) The economics of alien species invasions. In: Mooney, H.A. and R.J. Hobbs (eds). 2000. *Invasive Species in a Changing World*. Island Press, Washington, D.C.
- Oliveira S.H.F. (2009): Seedlings growth of the invader *Calotropis procera* in ironstone rupestrian field and seasonally dry forest soils. *Neotropical Biology and Conservation* 4(2): 69-76.
- Pomeroy R.S., Parks J.E. & Watson I.M. (2004) How is your MPA doing? A Guidebook of Natural and Social indicators for Evaluating Marine Protected Area Management Effectiveness. IUCN Gland, Switzerland and Cambridge UK, xvi + 216 pp. Accessed on 17/02/2016 <http://effectivempa.noaa.gov/guidebook/guidebook.html>
- Richardson, D.M., Cambray, J.A., Chapman, R.A., Dean, W.R.J., Griffiths, C.L., Le Maitre, D.C., Newton, D.J. & Winstanley, T.J. (2003) Vectors and pathways of biological invasions in south Africa – Past, Present, and future. In: Ruiz, G.M and Carton, J.T. (eds) 2003. *Invasive species: Vectors and Management strategies*. Island Press, Washington.
- Ruiz, G.M and Carton, J.T. (eds) (2003) *Invasive species: Vectors and Management strategies*. Island Press, Washington.
- Strayer, D. (2012) Eight questions about invasions and ecosystem functioning. *Ecology letters*: doi:10.1111/j.1461-0148.2012.01817.x.
- vanRensburg, B.J., Weyl, O.L.F., Davies, S.J., van Wilgen, N.J., Spear, D., Chimimba, C.T. & Peacock, D.S. (2011) Invasive vertebrates of South Africa. In: *Biological Invasions: Economic and environmental costs of alien plant, animal and microbe species*, second edition, ed. D. Primentel, New York.: CRC Press.

Appendix 1: Examples of IAS found in the parks

Due to the fact that the national parks do not allow introduction of domestic plants and animals, these species will be regarded as AIS wherever they occur in the parks. However, their control will depend on the level of threat they cause to the environment.

S/N	Scientific Name	Common Name	Local Name	Arusha NP	Gombe NP	Katavi NP	Kilimanjaro NP	Kitulo NP	Manyara NP	Mahale MNP	Mikumi NP	Mkomazi NP	Ruaha NP	Rubondo INP	Saadani NP	Saanane INP	Serengeti NP	Tarangire NP	Udzungwa NP	
1	<i>Acacia mearnsii</i>	Black wattle	Miwato																	
2	<i>Acacia melanoxylon</i>	Australian black wood																		
3	<i>Acrocarpus fraxinifolius</i>	Australian ash																		
4	<i>Agave sisalana</i>	Sisal	Katani																	
5	<i>Amaranthus hybridus</i>	Pig weed	Mchicha																	
6	<i>Anacardium occidentale</i>	Cashew plant	Koroshu																	
7	<i>Annona cherimoya</i>	Chirimuya																		
8	<i>Annona senegalensis</i>	Custard apple	Topetope																	
9	<i>Argemone mexicana</i>	Mexicana poppy																		
10	<i>Argemone ochroleuca</i>	Mexicana poppy																		
11	<i>Azadirachta indica</i>	Neem	Mwarobaini																	
12	<i>Azolla pinnata</i> <i>subsp. africana</i>																			
13	<i>Bidens kilimandscharica</i>																			
14	<i>Caesalpinia decapetala</i>	Mauritius thorn																		

15	<i>Calotropis procera</i>	Sodom apple																					
16	<i>Cassia occidentalis</i>	Coffee senna																					
17	<i>Cedrella odorata</i>	Spanish cedar																					
18	<i>Chromolaena odorata</i>																						
19	<i>Cinnamomum comphora</i>	Camphor wood																					
20	<i>Citrus lemonus</i>	Lemon	Mlimao																				
21	<i>Cupressus lusitanica</i>	Mexican cyprus																					
22	<i>Datura stramonium</i>	Devil's trumpet																					
23	<i>Datura erecta</i>	Devil's apple																					
24	<i>Elaeis guineesis</i>	Palm	Mchikichi																				
25	<i>Eriobotrya japonica</i>	Japanese plum																					
26	<i>Eucalyptus muculata</i>	Eucalyptus	Mkaratusi																				
27	<i>Eucalyptus citriodora</i>	Eucalyptus	Mkaratusi																				
28	<i>Eucalyptus maedenii</i>	Eucalyptus	Mkaratusi																				
29	<i>Eucalyptus panicula</i>	Eucalyptus	Mkaratusi																				
30	<i>Eucalyptus globulus</i>	Eucalyptus	Mkaratusi																				
31	<i>Eucalyptus saligna</i>	Eucalyptus	Mkaratusi																				
32	<i>Euphobia tirucalii</i>	Milk bush	Mnyaa																				
33	<i>Grevilea robusta</i>	Australian silver oak	Mwerezzi																				
34	<i>Jacaranda mimesfolia</i>	Jacaranda	Mjakaranda																				
35	<i>Jatropha curcas</i>	Jatropha	Mbono																				
36	<i>Lantana camara</i>	Lantana																					
37	<i>Lantana trifolia</i>	Three leaves shrub																					
38	<i>Leucaena leocophala</i>	Leucaena	Mlusina																				

39	<i>Mangifera indica</i>	Mango	Mwembe			■	■			■		■	■	■	■			■
40	<i>Manihot esculenta</i>	Cassava	Mhogo pori									■	■	■				
41	<i>Manihot glaziovii</i>	Cassava tree	Mpira				■						■	■				
42	<i>Musa sapientum</i>	Plantain	Migomba							■		■	■	■				
43	<i>Opuntia monacantha</i>	Prickly pea															■	
44	<i>Opuntia inermis</i>	Prickly pea										■			■		■	
45	<i>Opuntia vulgaris</i>	Prickly pea										■					■	
46	<i>Pinus caribea</i>	Carribean Pine	Msindano	■			■											
47	<i>Pinus patula</i>	Pine	Msindano				■	■										
48	<i>Pinus radiata</i>	Radiata pine	Msindano				■											
49	<i>Pistia stratiotes</i>	Water cabbage				■		■		■		■					■	
50	<i>Prunus serotina</i>	Black Cherry					■											
51	<i>Psidium guajava</i>	Guava	Mpera		■		■		■	■				■				
52	<i>Ricinus communis</i>	Castor oil	Mbarika/ Mnyonyo	■		■		■				■					■	
53	<i>Rorippa nasturtium-aquaticum</i>	Green Watercress							■									
54	<i>Schinus molle</i>	American Pepper															■	
55	<i>Senna siamea</i>	Cassia tree	Mjohoro			■			■	■	■	■	■		■			■
56	<i>Senna spectabilis</i>	Senna	Mjohoro						■	■				■				■
57	<i>Synadenium grantii</i>	African milk bush	Mkaburi										■					
58	<i>Thevetia Peruvianna</i>	Yellow oleander				■			■		■			■				
59	<i>Xanthium strumarium</i>	Rough cocklebur																■