

Eastern Cape Parks Board

Invasive Alien Plants – Strategic Management Plan Mkhambathi Nature Reserve

A subsidiary management plan to the Mkhambathi Nature Reserve strategic
management plan

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Glossary

APO – Annual Plan of Operations, the annual plan which defines the areas to be treated in a given financial years and the resources (e.g. personnel, equipment, budget) that will be required to achieve this plan.

CARA - Conservation of Agricultural Resources Act (No. 40 of 1983).

CapeNature – the provincial conservation board in the Western Cape.

DEAT – national Department of Environment Affairs and Tourism; the Environment Affairs directorates are being put under the new Department of Water and the Environment (DWEA).

Department of Water Affairs and Forestry, now part of DWEA; the Forestry directorate has been transferred to the national Department of Agriculture.

DEDEA – provincial Department of Economic Development and Environment Affairs in the Eastern Cape.

ECP - Eastern Cape Parks

Ezemvelo KZN Wildlife – the provincial conservation board for KwaZulu-Natal.

IAP - Invasive Alien Plant; generally refers to plant species which are proclaimed as weeds in terms of the CARA Weeds regulations and the National Biodiversity Act.

KRA – Key Result Area, a specific objective or outcome defined in the overall project logical framework (Logframe).

MUCP - Management Unit Control Plan; the Working for Water invasive alien plant management planning approach and tools.

NBA - National Environmental Management: Biodiversity Act (No. 10 of 2004).

NBAL – Natural Biological Alien – the smallest invasive alien plant management unit used by the Working for Water programme.

POS – Working for Water's Project Operating Standards. Version 3. May 2007.

PPRI – Plant Protection Research Institute, part of the Agricultural Research Council, responsible.

Reserve – the specific formally Protected Area.

SANBI – South African National Biodiversity Institute.

SANParks – South African National Parks Board.

SMP – Strategic Management Plan, the overarching plan for each Reserve.

WfW - Working for Water Programme.

WIMS - Working for Water Information Management System, the database and associated planning and management tools used by WfW for planning at the control project level and reporting at all levels up to national.

1 Introduction

Invasive alien¹ plants are widely recognized as a significant threat to the long term conservation of biodiversity and to human livelihoods and well-being. The Wild Coast is no exception. The range of invasive species and the degree of invasion of the Wild Coast is poorly known but a number of South Africa's major weed species are known to occur there and to be widespread. These species include: *Chromolaena odorata* (triffid weed), *Lantana camara* (lantana), *Caesalpinia decapatala* (Mauritius thorn), *Solanum mauritianum* (bugweed) and *Cestrum laevigatum* (inkberry). Under the National Biodiversity Act (NBA, No 10 of 2004), management institutions responsible for protected areas are obliged to develop strategies and management plans to control invasive alien species and minimize the threat to biodiversity (e.g. Mogobozi *et al.* 2008) that they pose. The draft Eastern Cape Parks (ECP) policy on alien and invasive species recognizes this obligation and sets out principles that the ECP will comply with in dealing with these species (ECP 2007).

The focus of this Invasive Alien Plant Management Plan is to provide a basis for annual plans of control operations that will be carried out over the next 5-years. This plan feeds into the objectives and purpose of the over-arching Strategic Management Plan (SMP) for the Reserve. One of key objectives of the SMP relates to Biodiversity and Heritage Resources and its aim is to:

Establish effective measures to conserve all elements of biodiversity in the Eastern Cape by 2010

This strategic objective clearly includes reducing the threats posed by invasive alien plants and this is where this Invasive Alien Plant Management Plan fits in.

In this plan the term “control” refers to the process of controlling alien plant invasions and covers all activities including biological control. The control operation at a site comprises a number of treatments which form a logical sequence aimed at reducing the density of invasions to a minimum, generally beginning with initial clearing, followed by a series of follow-up operations and then ongoing maintenance. The ideal is to eradicate the invading species but this is rarely possible so a more realistic goal is to reduce the density to a minimum and maintain it at that level.

Each individual management plan would have to have a specific 5-year target which would quantify the expected impacts and give a specific time frame based on:

- (a) the resources (e.g. manpower, skills, equipment, budget) that are available to control invasive alien plants;

¹ Alien is generally understood to mean a species introduced from outside South Africa and extra-limital to mean an indigenous species that is not indigenous to that area.

- (b) the extent, composition and density of the invasive species;
- (c) the methods required to deal effectively with those species (e.g. cut, cut and apply herbicide);
- (d) the conditions in the areas where control operations are required (e.g. accessibility, slopes); and
- (e) the priorities that have been set both in terms of areas and species to target first.

The estimates of persondays prepared for this plan do not include allowances for the terrain and accessibility. These factors are important but difficult to budget for without details of each specific area (NBAL) that is to be treated but can be allowed for at the level of planning that goes into an Annual Plan of Operations. In the first few months the emphasis will be on recruitment, training and organizing into teams so the target set for that year must take that into account.

This management plan has been designed to meet the requirements of the Invasive Species Regulations under the National Biodiversity Act. It provides the 5-year plan for implementation of the plan and the basis for the formulation of the Annual plans of Operations for that 5-year period. As the focus of the plan is on a 5-year time span, only the key elements of the annual planning and implementation have been included. Training in different aspects of invasive plant management, and other staffing issues, are an important component of management but have not been included in this plan which focuses on the actual invasive alien plant management operations. There are specific requirements for maintaining biocontrol reserves for certain agents (i.e. areas where the host plant species is protected so that the agent can reproduce and disperse to adjacent areas) which are too detailed and case specific to go into in this plan.

The objective for invasive alien plan management sets the overall aim; the sub-objectives address the sets of actions needed to achieve that objective in a logical sequence (Figure 1).

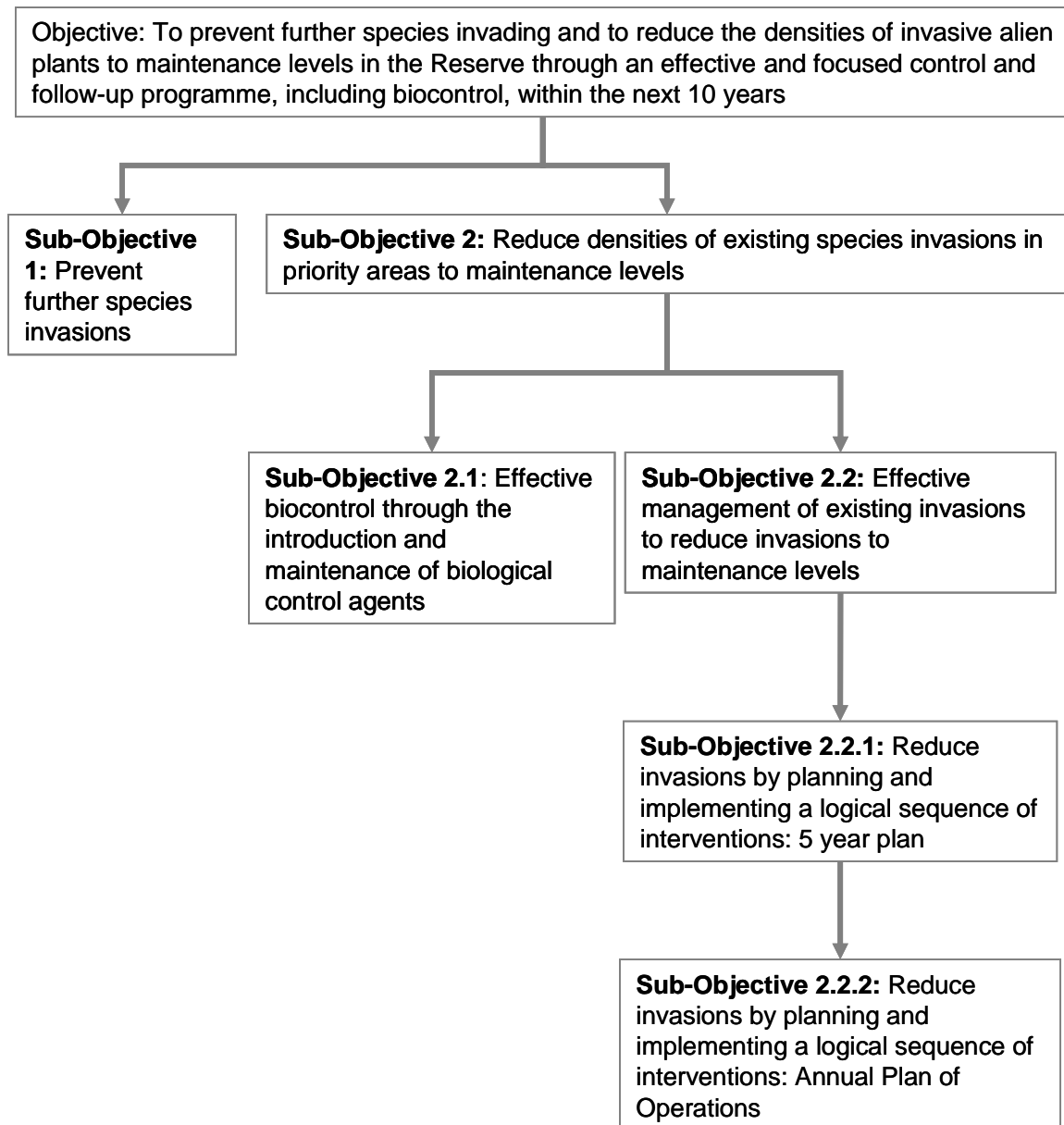


Figure 1. The hierarchy of objectives for invasive alien plant management.

2 Objectives, sub-objectives, actions, tasks, deliverables and responsibilities

The summary table below sets out the objectives and sub-objectives together with the actions that are needed to make progress towards achieving the objectives. The Actions describe the sets of Tasks needed to achieve a particular sub-objective. The actions and responsibilities set out what needs to be done and who is responsible for doing it or seeing that it gets done. The outputs and outcomes comprise evidence that can be used to evaluate the actions and their results by reserve managers, their regional managers and the scientific services staff.

RM = Reserve Manager (can also be a person designated and capable of doing this job but the RM has overall responsibility), SM = Regional Manager, SS = Scientific Services (regional ecologist), WIMS = Eastern Cape WfW Information Management System specialist.

| Actions | Tasks | Deliverables and outcomes for evaluation | Responsible person | Verification | |
|---|--|--|--------------------|--------------|--------------|
| | | | | Quarterly | Annual |
| Objective: To prevent further species invading and to reduce the densities of invasive alien plants to maintenance levels in the Reserve through an effective and focused control and follow-up programme, including biocontrol, within the next 10 years | | | | | |
| Sub-Objective 1: Prevent further species invasions | | | | | |
| Regular patrols of the Reserve by the staff to identify any species that have not been recorded before and new localities of existing species | Photograph species and record locality on a map. Collect specimens for identification, press and mount | Open a new file for this species. Mark the location(s) on a wall map as a record of new species Store a duplicate copy of specimen as submitted | RM | SM, SS | SM, SS |
| | Submit to experts for identification and whether or not it is a known invader | Record of species identification and of categorisation as invasive or not in file | RM | | |
| | If it is an invasive alien, determine whether there are any recommended control treatments and seek expert advice if unsure | Description of recommended treatment if available and written record of expert advice in file | RM | | |
| | Map and photograph the area where it occurs prior to treatment. If there are recommended treatments, deploy team to do treatments. If not remove the plants physically including all material. Re-take photographs after treatment. Add the information into database of treated areas (NBALs) to ensure that there is follow-up | Records of treatments carried out with photographs in file and the NBAL code it was assigned in the treatment database | RM | WIMS records | WIMS records |

| Actions | Tasks | Deliverables and outcomes for evaluation | Responsible person | Verification | |
|--|--|---|--------------------|--------------|--------------|
| | | | | Quarterly | Annual |
| | and add copies of photographs to file | | | | |
| | Map and photograph new locations of existing species and include records in the NBAL database | Records of new localities in the NBAL database | RM | WIMS records | WIMS records |
| Sub-Objective 2: Reduce densities of existing species invasions in priority areas to maintenance levels | | | | | |
| Sub-Objective 2.1: Effective biocontrol through the introduction and maintenance of biological control agents | | | | | |
| Establish biocontrol agents for all the species where an agent is available | Commission an assessment by a biocontrol specialist of the current situation with recommendations on actions to be taken | Specialist report on the situation with recommendations | RM, WfW | | |
| | Implement the recommendations | Record of decisions and actions taken in relation to each recommendation and the outcomes | RM, WfW | | SM, SS |
| Monitor and evaluate the effectiveness of the agents | Request annual inspections by the regional WfW biocontrol implementation specialist | Annual reports on inspections and recommendations | RM, WfW | | |
| | Implement the recommendations | Record of decisions and actions taken in relation to each recommendation | RM, WfW | | |
| | Evaluate the outcomes | Record of evaluation and decisions taken on the evaluation | RM, WfW | | SM, SS |
| Sub-Objective 2.2: Effective management of existing invasions to reduce invasions to maintenance levels | | | | | |
| Sub-Objective 2.2.1: Reduce invasions by planning and implementing a logical sequence of interventions: 5 year plan | | | | | |
| Develop the 5-year | Prepare 5-year management plan | | | | |

| Actions | Tasks | Deliverables and outcomes for evaluation | Responsible person | Verification | |
|---|--|---|--------------------|--------------|--------|
| | | | | Quarterly | Annual |
| plan or revise existing 5-year plan after 5-years | Map, or update the existing map, of the entire reserve to the Working for Water Standards | A map showing the state of invasions in the reserve at a particular time | RM, SS | | |
| | Assess the current situation | Documented assessment of the situation based on mapped data and available resources | RM, SS | | SM |
| | Define new priorities for treatment | Documented priorities and proposed actions | RM, SS | | SM |
| | Prepare plan based on the assessment and priorities | 5-year plan | RM, SS | | SM |
| | Revise 5 year plan during its 5 th year of implementation or as the need arises | | | | |
| | Compare current and historical invasions to assess whether the overall distribution and density of invasions has been reduced in line with the existing priorities | Written assessment of overall progress based on data from the treated areas (NBAL) | RM | | SM, SS |
| | Revise 5-year plan to incorporate the new priorities and proposed actions | New or revised 5-year plan with priorities and proposed actions | RM | | SM, SS |
| | Prepare revised plan based on the assessment and priorities | Revised 5-year plan | RM, SS | | SM |
| Sub-Objective 2.2.2: Reduce invasions by planning and implementing a logical sequence of interventions: Annual Plan of Operations | | | | | |
| Prepare APO for invasive alien | Compile a list of priorities activities and the NBALs ordered according to those priorities) | List of priorities | RM | | |

| Actions | Tasks | Deliverables and outcomes for evaluation | Responsible person | Verification | |
|--|---|---|--------------------|--------------|--------|
| | | | | Quarterly | Annual |
| plants (see the next table for more details) | Prepare provisional estimates of the resources (persondays, equipment, materials) required per NBAL using the WfW APO planning system | WfW budgeting spreadsheet with prioritised NBALs and the resources required to complete the APO | RM, Clerk | | |
| | Based on the available budget and capacity, prepare a final list of prioritised NBALs and finalise the APO | Completed APO signed off by all parties | RM, Clerk | | SM, SS |

Sub-objective 2.2.2 above set out the general requirements for preparing an Annual Plan of Operations. The summary below sets out a typical sequence of activities that will be followed when implementing the section of the APO that deals with invasive alien plant management.

| Actions | Tasks | Deliverables and outcomes for evaluation | Responsible person | Verification |
|---|--|--|---------------------------|---------------------|
| Implement APO for invasive alien plants | Using the WfW standards map, clearly demarcate NBALs using GPS and field markers and photograph the area; load GPS records into computer and add data to the WIMS information system | Record of mapped NBAL on file and on WIMS system (see sections 5.4 and 7.3) | RM | |
| | <i>For each NBAL and treatment in order of priority (see sections 5.4 and 7.3)</i> | | | |
| | Agree with team on the resources required to treat each NBAL | Record changes from planned resources in APO | RM, Clerk | |
| | Draw up a contract for each NBAL as specified in the WfW standards | Final signed contract on file | RM | |
| | On completion of treatment, assess each NBAL to ensure that the quality of work meets the standards | Written assessment of the quality of the treatment on file | RM | |
| | Where the treatment of an NBAL does not meet the standards, specify the necessary additional work | Written record of the additional work signed by both parties on file | RM | |
| | When the treatment of an NBAL has been successfully completed sign off | Written record signed off by both parties on file | RM | SM |
| | Retake photographs of the treated area (NBAL) | Copies of photographs on file | RM | |
| | Monthly: assess progress based on the list of prioritised NBALs and resources and time expended to date | Monthly report to go to the SM and WfW; quarterly evaluation agreed by both parties with actions to address progress where it deviated from the plan | RM | RM, SM |
| | Annually: assess progress based on the list of prioritised NBALs and resources and time expended | Annual report to go to the SM and WfW; annual evaluation agreed by all parties with actions to address progress where it deviated from the plan | RM | RM, SM, SS |

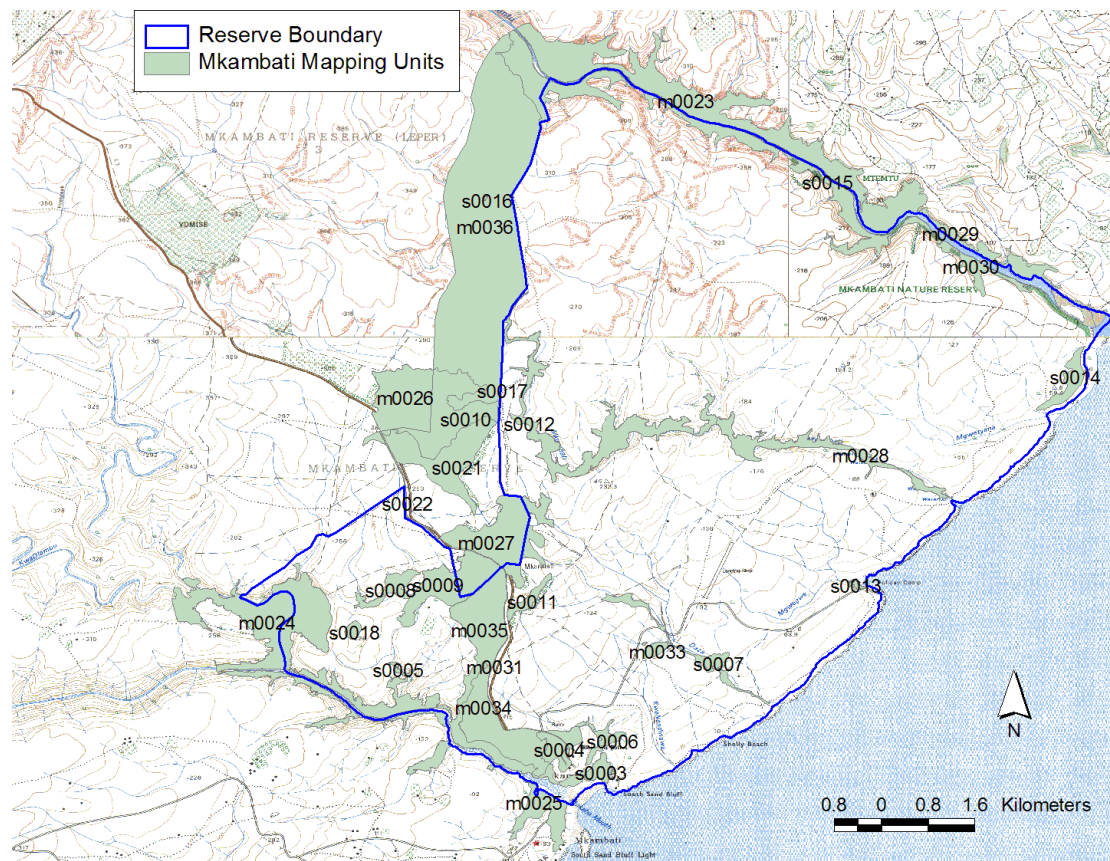
3 Situation Assessment

3.1 State of invasions

This section provides an overview of the current situation in regard to invasive alien plants in the Reserve.

Current invasions

The invasions in the Reserve and a buffer strip extending 1 km beyond the boundary were mapped by Conservation Support Services in March 2009 (Map 1). The species composition, density and distributions were mapped using the Working for Water standards and the species included all those proclaimed as weeds under the CARA Regulations.



Map 1. The Mkhambathi Reserve showing the homogeneous mapping units as defined in March 2009. The mapping included a 1km wide buffer zone around the reserve.

Alien plant species have invaded about 2276 ha of the total of 10 829 ha that was mapped in and around Mkhambathi to some degree. The condensed invaded area² is about 268 ha, equivalent to a mean percentage cover (density) of 1.81% over the whole mapped area and 11.76% cover in the total invaded area. The buffer zone comprised 3 186 ha (compared with 7 629 ha in the reserve) but accounts for roughly 67.5% of the condensed invaded area. The extensive grassland areas in this reserve are relatively free from invasive woody species largely because of the frequent fires. It is likely that a reduction in the fire frequency (increase in the interval between successive fires) would result in a rapid increase in invasions as there are several well-dispersed and aggressive species which could invade.

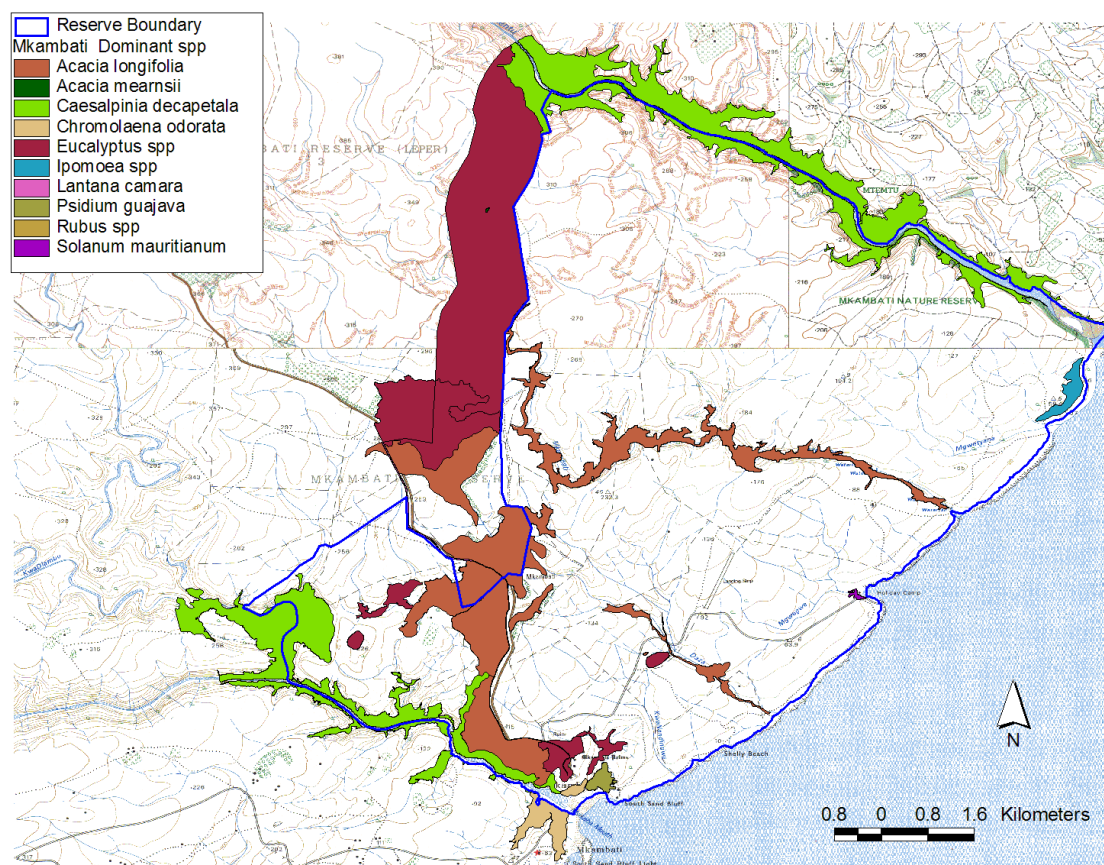
The dominant species are the *Eucalyptus* species (mostly in current or former plantations and mainly in the buffer, Table 1, Map 2) while *Acacia longifolia* and *Caesalpinia decapetala* (Mauritius thorn) are widespread. *Acacia longifolia* is particularly prominent in the river valleys in the reserve as it is being dispersed downriver from the plantation areas on the Tracor land (Map 1). *Caesalpinia decapetala* is the dominant species in the both the Mtentu and Msikaba River valleys together with a range of other species including *Chromolaena odorata*. The cleared *Eucalyptus grandis* plantations in the vicinity of the office have been invaded by a number of other species.

Table 1. Summary of the areas invaded by different species in the Mkhambathi Reserve including the 1 km wide buffer zone. The area given is the condensed or equivalent dense area¹.

| Species | Condensed Area (ha) | |
|-------------------------------|---------------------|--------|
| | Inside | Buffer |
| <i>Acacia baileyana</i> | 0.003 | 0.000 |
| <i>Acacia longifolia</i> | 16.960 | 29.680 |
| <i>Acacia mearnsii</i> | 4.280 | 16.940 |
| <i>Ageratum conyzoides</i> | 0.007 | 0.010 |
| <i>Caesalpinia decapetala</i> | 15.620 | 21.750 |
| <i>Callistemon</i> spp. | 0.003 | 0.000 |
| <i>Canna indica</i> | 0.007 | 0.010 |
| <i>Chromolaena odorata</i> | 2.020 | 3.320 |
| <i>Cortaderia</i> spp. | 0.003 | 0.000 |
| <i>Datura</i> spp. | 0.001 | 0.000 |
| <i>Eucalyptus</i> spp. | 7.220 | 36.700 |
| <i>Hedychium</i> spp. | 0.000 | 0.220 |
| <i>Ipomoea</i> spp. | 3.860 | 5.120 |
| <i>Lantana camara</i> | 7.165 | 8.940 |
| <i>Melia azedarach</i> | 0.010 | 0.020 |
| <i>Montonoa hibiscifolia</i> | 0.074 | 0.110 |
| <i>Pinus</i> spp. | 0.127 | 0.110 |
| <i>Plectranthus comosus</i> | 0.127 | 0.000 |

² The condensed or equivalent dense area is an adjustment of the total invaded area to the equivalent area at 100% canopy cover e.g. 100 ha with a 5% cover of a species is equivalent to 5 ha of 100% invasion. This was originally done for estimation of impacts on water sources but it also provides a convenient way of comparing invasions by different species.

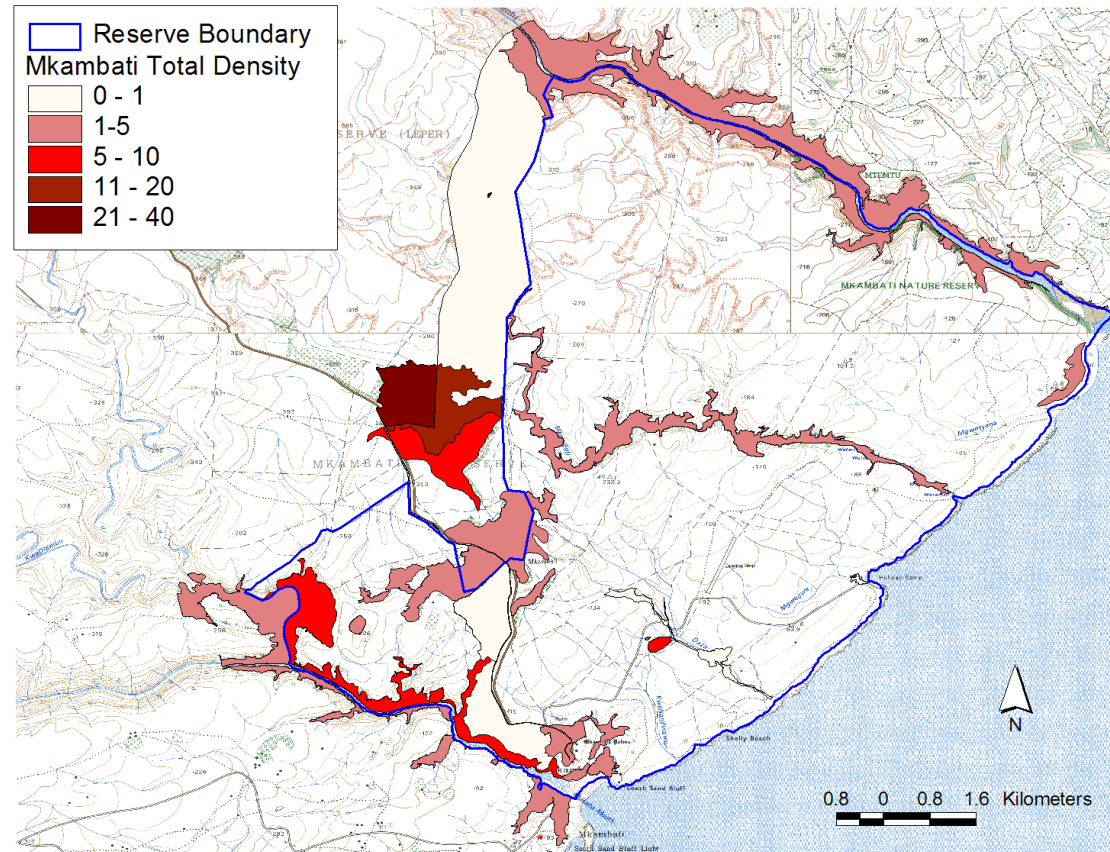
| Species | Condensed Area (ha) | |
|----------------------------|---------------------|-------|
| <i>Plumeria</i> spp. | 0.003 | 0.000 |
| <i>Psidium guajava</i> | 1.422 | 1.110 |
| <i>Ricinus communis</i> | 0.007 | 0.010 |
| <i>Rubus</i> spp. | 0.080 | 0.160 |
| <i>Sesbania punicea</i> | 0.790 | 0.730 |
| <i>Solanum mauritianum</i> | 3.390 | 6.600 |
| <i>Solanum</i> spp. | 0.016 | 0.030 |



Map 2. The Mkhambathi Reserve showing the dominant invasive species as mapped in March 2009. The mapping included a 1km wide buffer zone around the reserve.

The highest density invasions are found in the buffer strip around the reserve where they range from 10-40% cover (Map 3). Most of the invasions in the reserve are in the 5-10% cover class. There are extensive and relatively dense invasions in all the river valleys, particularly the Mtentu, Msikaba and Mkhambathi Rivers and the densities increase upstream. This shows the characteristic pattern of seeds dispersed downriver, establishing and reaching reproductive maturity and their seeds than being dispersed upslope away from the original areas they colonised. The species composition also reflects dominance of grassland and the limited area of forest in the reserve (which is generally uninvaded) and the forest in the river valleys which generally is invaded. The plantation area just outside the reserve appears to be a potentially important source of invasive species as a wide range of species were recorded there (and also noted in the other plantations outside the mapped area). The area in the

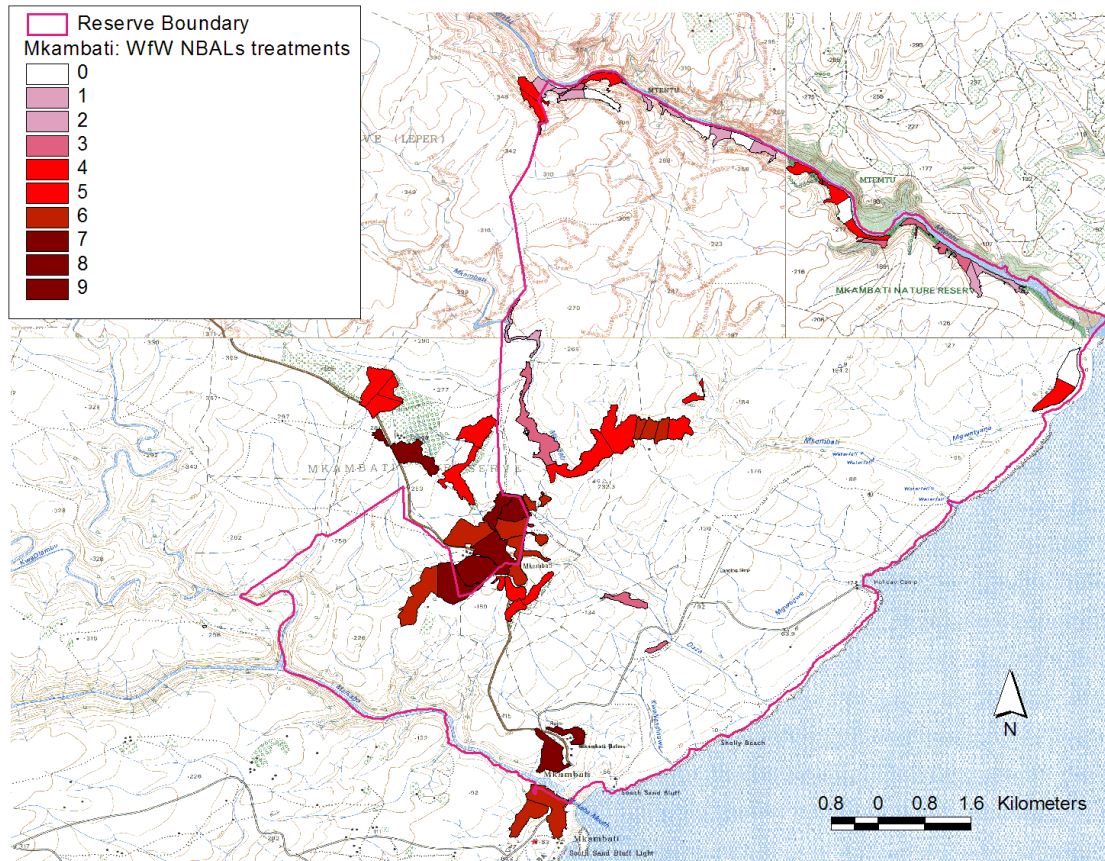
vicinity of the main gate is heavily invaded by at least 15 species and is probably the source of the invasive species along the Daza River. The main camp area contains one of the highest concentrations of alien species within the reserve, particularly the grounds of the clinic which seem not to have been cleared.



Map 3. The total density (% cover) of invasive alien plants in the Mkhambathi Reserve based on mapping done in March 2009.

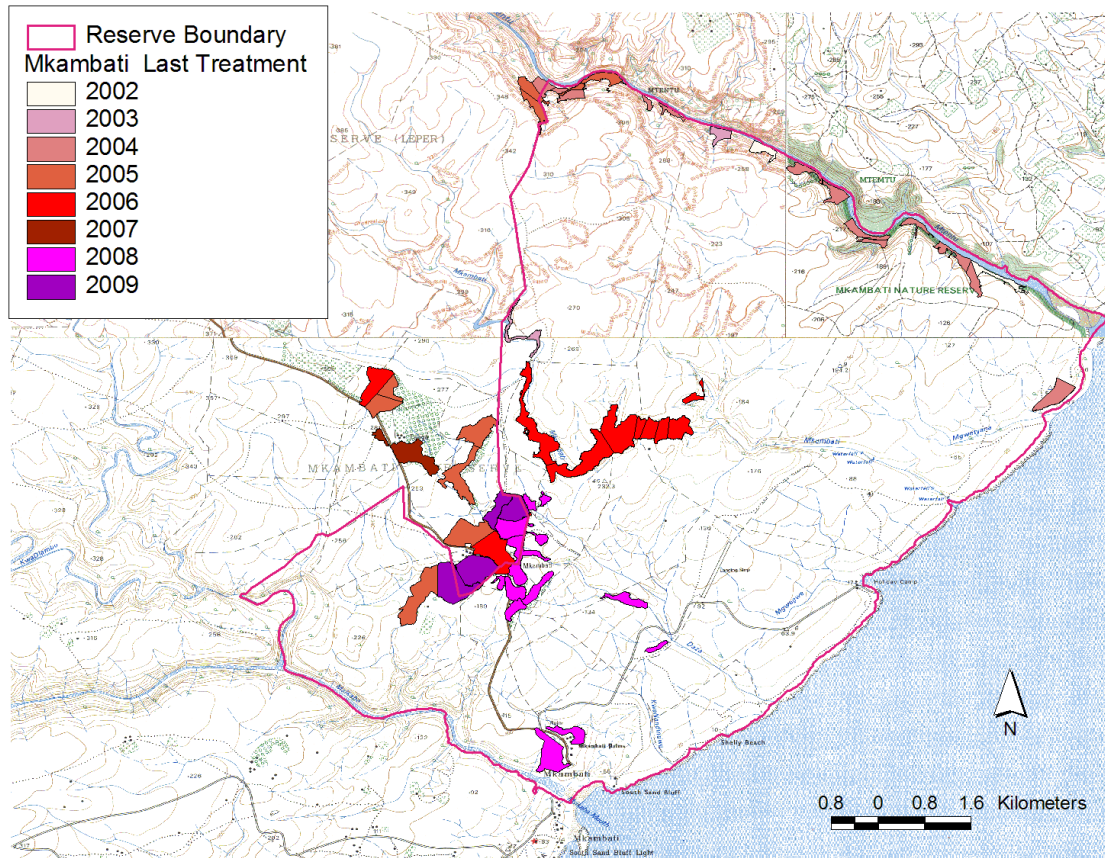
History of control operations in the Reserve

We have not been able to find detailed records of invasive plant control operations prior to the clearing done by Working for Water. The WfW records date back for a number of years and many of the treated areas have received initial clearings and by several follow-up treatments (Map 4). Some of the areas have only been treated once or twice, notably those in the Mtentu River valley and the upper Mkhambathi River.



Map 4. The location of the areas (NBALs) as set out by the Working for Water programme and the number of treatments that have been applied. Some of the NBALs have not had any treatments yet.

In Mkhambathi the last treatment records were for the 2008 calendar year (Map 5) and all of the recent treatments have been in the area around the main camp and the main entrance including those that were completed during February 2009. The initial work by the Working for Water programme was not particularly effective but now that the teams are being directed by the reserve manager the follow-ups are being more systematically done and good progress has been made. Nevertheless, in the areas where it has been a long time since the last treatment, many of the invasive species will have recovered and the clearing will have to be redone from scratch. The current progress demonstrates that it is possible to achieve the objective of this plan. During the workshops in November 2009 we pointed out to the management that they were cultivating Candelabra plant (*Bryophyllum delagoense*, Mother of millions), a declared invader in pots outside the reception. Tickseed (*Coreopsis lanceolata*) was being cultivated in the flowerbeds outside the conference centre. Neither of the species may be cultivated, especially not in a protected area. Hopefully these species have now been dealt with.



Map 5. The location of the areas (NBALs) set out by the Working for Water programme and the calendar year of the last treatments.

Scope of the problem

Only a small proportion of the reserve has been moderately densely invaded by a range of species, the main areas being in and around the built up areas, the former plantations, the valleys of the rivers that start outside the reserve (E.g. Mtentu, Msikaba and Mkhambathi Rivers), and a few small isolated patches. There have been control operation in the reserve for several years. These interventions have made good progress in some areas with the initial but the follow-up has (until recently) not been adequate. In effect, some of the control operations are being restarted but the opportunity is there to continue or restart treatments in the NBALs treated by WfW. In Table 2, the persondays have been summarised for each mapped invaded area in the reserve.

Each of the map units (MUs) has been invaded by a certain combination of species, age groups and density classes. The data on the species, age and density class, and the treatment required have been entered into the WfW APO planning spreadsheet which calculates the person days based on existing work norms.

The number of persondays required per MU is obviously directly related to its size but the canopy cover and size class (an index of density) also play a significant role as can be seen in the ones dominated by dense *Eucalyptus* stands. In total, the initial clearing of the 2 275 ha of mapped MUs will require roughly 5 247 persondays. Given that a year comprises about 250 working days (50 weeks * 5 days per week), this is equivalent to about 21 person-years so a team of 21 workers should be able to complete this work in about year. The total persondays for the MUs which fall inside the reserve is about 3 969 or about 16 person-years, so only about a quarter of the total resources would be required to do an initial clearing of the reserve itself. In the long run this would not be effective, especially along the rivers so the longer-term plan must always be to clear the reserve and the 1km buffer.

However, as pointed out earlier, species such as *Chromolaena decapetala*, *Caesalpinia decapetala* and *Lantana camara* will probably need follow-up within 3-6 months which means that most clearing units will needed to be treated at least twice in a year. Therefore only a subset of the units can be treated in year 1 because follow-ups must take priority over clearing of new areas. The number of NBALs that actually can be treated will also depend on many other factors including the costs of salaries, transport, actual treatments and herbicides used and other items and the resources available for clearing. The inclusion of these costs is beyond the scope of this management plan but provision is made for all these costs in the APO planning spreadsheets.

Table 2. A summary of the key information on each mapped unit (MU) in the Mkhambathi Nature Reserve. The MUs in bold are ones that fall inside the reserve, the rest are in the 1km buffer strip outside the reserve. The persondays were estimated from the Working for Water norms in the spreadsheet used to prepare the Annual Plan of Operations for each project.

| Mapped Unit | Dominant species | Cover (%) | Total cover (%) | Area (ha) | Person-days |
|--------------------|-------------------------|------------------|------------------------|------------------|--------------------|
| m0023 | Caesalpinia decapetala | 5 | 9.1 | 249.50 | 475 |
| m0024 | Caesalpinia decapetala | 5 | 7.5 | 146.57 | 198 |
| m0025 | Chromolaena odorata | 2 | 4.6 | 37.21 | 34 |
| m0026 | Eucalyptus spp | 40 | 88.1 | 82.53 | 1493 |
| m0027 | Acacia longifolia | 5 | 20.0 | 108.94 | 483 |
| m0028 | Acacia longifolia | 2 | 3.5 | 53.56 | 32 |
| m0029 | Caesalpinia decapetala | 2 | 3.4 | 78.91 | 50 |
| m0030 | Caesalpinia decapetala | 2 | 6.5 | 26.89 | 35 |
| m0031 | Eucalyptus spp | 0 | 0.2 | 1.89 | 1 |
| m0032 | Acacia longifolia | 2 | 2.0 | 0.22 | 1 |
| m0033 | Eucalyptus spp | 10 | 10.0 | 6.06 | 9 |
| m0034 | Acacia longifolia | 1 | 2.0 | 86.79 | 48 |
| m0035 | Acacia longifolia | 1 | 1.0 | 78.30 | 30 |

| Mapped Unit | Dominant species | Cover (%) | Total cover (%) | Area (ha) | Person-days |
|-------------|------------------------|-----------|-----------------|-----------|-------------|
| m0036 | Eucalyptus spp | 0 | 0.1 | 551.62 | 5 |
| s0002 | Chromolaena odorata | 2 | 4.1 | 5.41 | 4 |
| s0003 | Psidium guajava | 2 | 4.2 | 11.97 | 11 |
| s0004 | Eucalyptus spp | 5 | 14.7 | 26.94 | 112 |
| s0005 | Caesalpinia decapetala | 6 | 8.5 | 157.83 | 241 |
| s0006 | Eucalyptus spp | 5 | 11.0 | 12.66 | 30 |
| s0007 | Acacia longifolia | 1 | 2.3 | 25.26 | 60 |
| s0008 | Eucalyptus spp | 5 | 12.0 | 19.83 | 9 |
| s0009 | Acacia longifolia | 5 | 19.8 | 73.59 | 292 |
| s0010 | Eucalyptus spp | 20 | 60.5 | 87.42 | 971 |
| s0011 | Acacia longifolia | 4 | 10.0 | 11.46 | 17 |
| s0012 | Acacia longifolia | 4 | 8.1 | 103.34 | 150 |
| s0013 | Solanum mauritianum | 1 | 0.6 | 1.98 | 1 |
| s0014 | Ipomoea spp | 2 | 2.1 | 20.40 | 8 |
| s0015 | Caesalpinia decapetala | 5 | 9.1 | 101.33 | 178 |
| s0016 | Acacia mearnsii | 30 | 32.0 | 0.24 | 2 |
| s0017 | Rubus spp | 1 | 2.1 | 6.28 | 1 |
| s0018 | Eucalyptus spp | 5 | 5.0 | 5.29 | 8 |
| s0021 | Acacia longifolia | 9 | 20.1 | 90.84 | 256 |
| s0022 | Lantana camara | 1 | 2.1 | 4.83 | 2 |

4 Priorities for invasive alien plant management

In this section we make some provisional recommendations based on the data on the status of the current invasions. Additional information is provided in the following sections:

- General guidelines for prioritization (section 6.1)
- Specific context of the Reserve (section 6.2)
- The resources (human resources, funds, equipment) available (section 6.3)

Recommendations:

1. **Species based prioritisation:** Given the generally multi-species nature of the invasions prioritisation for control should be based on areas rather than species. The one critical priority is to ensure that there is effective biocontrol on the species for which there is effective control (Sub-Objective 2.1). This is particularly important for the plantation areas which have a variety of invasive species and are a major source of seeds for the invasion of the adjacent areas and the Mkhambathi River valley. *Acacia longifolia* evidently has effective biocontrol but there was little evidence of much impact on other species (e.g. *Caesalpinia*). The first step is to get the WfW regional biocontrol specialist to assess the situation in the Reserve and the plantations if this has not already been done. Further planning should be based on the outcome of

this assessment. Particular attention should be given to the species in the plantation areas as these will be a continual source of seeds for re-invasion of Mkhambathi itself until the species there are brought under effective control.

2. Area based prioritisation:

- a. In the case of this Reserve we suggest that an area-based prioritisation be adopted which assigns the first priority to clearing the terrestrial environments within the Reserve, particularly the invasions associated with the river systems that fall within the reserve (e.g. Daza R) or extend partially beyond its borders (e.g. Mkhambathi R).
- b. The areas in the vicinity of the entrance and around the lodge have been the main historical focus (Map5) and this work needs to be taken through to the maintenance stage. This means that the first priority for ongoing clearing supported by Working for Water should go to follow-up on the work done to date.
- c. At the workshop with the management and community representatives in November 2009 the area of *Ipomoea* in the north-eastern part of the reserve (s0014, Map 1) were identified as a priority because:
 - i. it well defined and
 - ii. is not densely invaded.
 - iii. The community believed that clearing the area would be within the capacity of a newly established team.
 - iv. If there are resources available to establish an additional clearing team they should undertake the necessary follow-up on this area. This would also build on the priorities determined in the workshop and thus facilitate ongoing participation by, and support from, the local community (see section 8).
 - v. There is a similar limited invasion in the vicinity of the GweGwe camp (s0013, Map 1) which could be the second priority for this team.
- d. The next priority should go to the Daza and Mkhambathi River valleys. The upper part of the Mkhambathi River (outside the reserve) needs to be cleared to deal with the primary source of the seeds for *Acacia longifolia*. The local community and any other institution involved in the management of the former Tracor land should be consulted first to determine if there are conflicts of interest. The forestry company was planning to close its operations and abandon the plantations within two years if a solution to the frequent wildfires could not be found. These wildfires are apparently caused by youths from local communities. The representatives at the November workshop indicated that they would support the clearing of this area and the former plantations.

- e. The Mtentu and Msikaba River valleys area problematic because they are exposed to ongoing invasion from seeds carried down river. The best option would be to do the initial clearing and then focus on limiting re-invasion by periodic follow-up but this should be given a lower priority than operations inside the reserve and the 1 km buffer.
- f. The plantations should be given a high priority but this is only feasible if sufficient resources can be found to deal effectively and rapidly with this heavily invaded area. The risk in prioritising these areas is that they could absorb all the available resources for the next few years, leaving nothing to deal with the invasions in the reserve itself. The control teams could also become discouraged by the sheer magnitude of the problem unless sufficient resources can be provided for them to be able to see clearly that their rate of progress is such that they will be able to complete it.
- g. In Mkhambathi the current fire regime is one of the key factors that appears to be limiting the extent and density of invasions. The one area where frequency of fires seems to be low is around the lodge. The grasslands and bush invaded areas around the lodge and reception should be assessed to determine whether to begin to deal with the problem by increasing the frequency and intensity of the fires. This could be done in combination with the fire protection of these facilities and their infrastructure.

5 How this plan links to the APO

This plan provides an overview of the current state of invasions and puts forward a provisional set of priorities for clearing over the next five years. The next step is to translate this strategic plan into an APO. This includes the following the steps set out in section 2 and is the responsibility of the persons identified in each step. A key input that is missing at this stage is an estimate of the resources that will be available to carry out the control treatments (section 5.3). This can only be determined once the detailed annual alien plant control budget for each Reserve is known. This budget will determine the number of person-days and other resources (e.g. equipment, chemicals, transport) that are available for control treatments. The steps set out below are based on the assumption that the available person-days are known. Initially the available person-days will include the time required to train the team members with the necessary skills.

5.1 Working for Water's approach

Before describing these steps it is necessary to explain some basic aspects of WfW's procedures. This information will be explained in much greater detail in the training courses but some background is useful at this point. The WFW mapping system is based on assigning a unique code to every treatment unit (polygon) that is cleared. These basic units are termed NBALs (Natural **B**iological **A**lien), a mnemonic which is derived from a standard system for coding all forms of land-cover.

Each NBAL is assigned a code based on the quaternary catchment it is located in, the subdivision of that catchment and the number which shows the order they were established in. These codes are assigned by the manager based on those already existing in the project area when the plan is implemented. The codes start with the name of the quaternary catchment in which the project is situated, followed by a subdivision of that quaternary and then by the number of the area demarcated for the control operation. The code is used to track each treatment that is applied to an NBAL, when it was done, the resources required and the effectiveness of the treatment.

5.2 Meetings and other basic administrative matters

The WfW standards require a project's manager, in this case the reserve manager, to provide monthly and annual reports on the alien plant control activities to WfW. ECP should adopt the same reporting periods to minimise additional reporting. Once the initial stages of implementation are past, reporting on alien plant control should be included on the agenda of the standard meetings between reserve managers, regional management and scientific services. Meetings between the control teams and the reserve manager should take place at least once a week to ensure that the work is on track and to take action where necessary to address any problems.

5.3 Mapping

The mapping of the Reserve in this plan has been done to get data on the extent, composition, and density of the invasions. When the individual treatment units (NBALs) are laid out, the original data should be checked to ensure they are still valid. Mapping of the NBAL is done prior to each treatment operation so that the information can be used in setting up the contract for that treatment in that NBAL. Mapping of the entire reserve only needs to be done when the next 5-year plan is compiled.

5.4 Executing and monitoring control operations

The following items only deal with the essential steps in executing and monitoring control treatments, for more details see WfW (2007).

1. Divide the area into management units – Reserve manager with input from WfW:
 - a. Begin with the top priority area as determined above and select a management unit.
 - b. A management unit (NBAL) size should be sized so that it would take about 300 person-days of work to clear based on the WfW norms.
 - c. It should cover an area within which the invasions are similar (homogenous) to simplify the estimation of the inputs needed to clear it.
 - d. The boundaries should be defined by natural features or otherwise clearly indicated.

- e. Identify sites where it is likely that rehabilitation may be needed and obtain input from scientific services on suitable rehabilitation measures.
2. Identify Biological Control Sites – Reserve manager with input from WfW:
 - a. Implementation of biocontrol is a top priority
 - b. Identify suitable sites with input from the regional WfW biocontrol implementation staff
 - c. Locate and mark the sites on the map showing the state of invasions in the Reserve
3. Identify and demarcate special areas where alien plant species should not be cleared (e.g. plantings with cultural significance)
4. Develop the Annual Plan of Operations (APO) - Reserve manager with input from WfW:
 - a. Select management units and add them to the standard APO spreadsheet
 - i. Insert the NBAL number.
 - ii. Add the data on the species, their densities and their size/age class in each NBAL.
 - iii. Select the planned treatment phase (e.g. initial clearing, first follow-up).
 - iv. Select the appropriate treatment (e.g. hand-pull, cut & fell, herbicide).
 - v. Keep a running total of the person-days.
 - vi. Repeat steps i-v until the person-days approximate the budget available for control treatments (i.e. excluding training and management overhead costs).
 - vii. The system does not provide for rehabilitation at this stage, do not forget to include it.
 - viii. Plan for one or more follow-up treatments within the same year where the species requires them (e.g. *Chromolaena odorata*). This can be done by re-entering the NBAL data and selecting the appropriate follow-up treatment.
 - b. Check that there are still resources available to treat further NBALs, if not then that is the set of NBALs that can be treated for the year.
 - c. Add the rest of the information needed to complete the APO for the year.
5. Submit the APO to regional management & scientific services to obtain their approval - Reserve manager
6. Implement the APO – Reserve manager with the control team & team leader (contractor)
 - a. Identify and mark out the NBALs on the site
 - b. Inspect the area with the clearing team (contractor) and:
 - i. Get agreement on the resources required to execute the planned treatment.
 - ii. Agree on the methods and standards to be applied.

- iii. Finalise and sign-off on the contract; include a map of the NBAL showing the features that demarcate it.
 - c. Take fixed point photographs prior to commencing the treatment. These points should be permanently marked and the co-ordinates should also be recorded using a GPS.
 - d. Monitor progress with the treatment and confirm that progress is as expected
 - e. If it is not as expected, agree with the control team on how to remedy the situation, where necessary.
 - f. When the treatment has been completed inspect the NBAL area to:
 - i. Make sure the treatment has been completed as specified in the contract (there is a specific form to complete).
 - ii. If the treatment does not meet the standard agree with the team (contractor) on what still needs to be done and ensure that it is.
 - iii. If the treatment meets the standard, complete the evaluation form and sign off.
 - iv. Make a copy of the signed evaluation form for your own records and submit the original to the regional manager.
 - g. Move to the next NBAL and repeat the steps above
7. Monthly reporting
- a. Prepare monthly reports on the progress of the control operations.
 - b. Ensure that all treatment information is captured for each NBAL.
 - c. Document cases where clearing team performance does not meet expectations and reasons why this occurs.
8. Annual reporting
- a. Provide a summary of the progress, effectiveness of treatments, outcomes of corrective measures (where necessary) and any other relevant information.

5.5 Rehabilitation

At present, WfW rarely use active restoration because the projects generally rely on the recovery of the natural vegetation. The results of treatments generally are not well documented but some recent reviews and studies provide some useful insights, albeit mainly for riparian environments (Holmes et al. 2005, 2008; Esler et al. 2008). One of the key problems is that treatments often fail to provide effective control of the invading species, often replacing one problem with another (worse) one (Beater et al. 2008; Witkowski and Garner 2008). These two studies were conducted in grassland and savanna environments in Mpumalanga, but they do highlight some important issues. The first is the failure to undertake the necessary follow-up treatments or to ensure that the treatments are effective (i.e. that chemical and mechanical treatments achieve a high kill rate) (Goodall and Zacharias 2002; Morris et al. 2008). The second is that the natural recovery of the natural vegetation is insufficient to provide a good cover and allows alien species to re-establish or re-colonise. In some cases there is evidence that active restoration of the vegetation (for example by reintroducing appropriate indigenous species from seeds) is needed to ensure rapid vegetation

recovery (Goodall and Erasmus 1996; Goodall and Zacharias 2002; van Gils et al. 2006; Holmes et al. 2005, 2008; Holmes 2007).

6 General guidelines for prioritisation

6.1 Basic principles

There are some very broad and basic, but nevertheless central, principles for control operations which have been summarized by WfW (Undated a, 2008) (see also Foxcroft et al. 2007; van Wilgen et al. 2007). These are mainly intended for control operations in riparian zones but most of the principles are applicable to other environments as well. These guidelines have been expanded on and customised for this plan:

- Follow-up always takes precedence over the initial control of new areas; failure to follow-up in time wastes the resources spent on the previous operation(s). This is important because some of the species found on the Wild Coast, notably *Chromolaena*, can resprout and produce seeds within 2-3 months of being treated. Follow-up has to be timed to prevent this so the treatment unit (NBAL) must be followed-up at least two to three times within the first year. Resource planning has to allow for this.
- Control low density invasions before dense invasions; this is because (a) controlling low-density areas removes invaders before they really suppress or displace the indigenous vegetation so that recovery of the natural vegetation is more rapid; and (b) a greater area can be treated per unit of resources.
- Control operations in riparian zones should, wherever possible, start from the top of a river system and progress downstream; this is because many riparian invaders are dispersed by water and move downstream; this is not possible where rivers have their headwaters well outside the protected area but can be done where the entire system is inside the protected area or only extends a short distance outside the protected area.
- Ensure that appropriate biocontrol agents are introduced unless they are already known to be present and effective. The longer the agents have to attack their target species the more effective they are; this, in turn, can reduce treatment costs, especially the follow-up, where seed feeders are used. This needs to be explicitly catered for in the initial APO and for subsequent years as specified by, and agreed with the WfW projects active in the Wild Coast.
- Ensure that control operations are integrated with other operations to ensure that the potential synergies are realised. The primary one in these protected areas is the management and use of fire. In general, fire can be a useful in conjunction with control operations, but it will not be sufficient on its own as the species that have invaded these areas (Appendix 1) are able to cope or even thrive with the fire regimes in the natural vegetation of these reserves (e.g. *Psidium guajava*, *Lantana camara*). Frequent fires may be useful in keeping some species from establishing in grasslands (e.g. *Chromolaena odorata* Goodall and Erasmus 1996; Goodall and Zacharias 2002)

but reductions in fire frequency will allow such species to establish. Vegetation which burns less frequently, such as the forest fringe, is very vulnerable to invasion because of the generally lower fire frequencies.

- Ensure that treatment units (NBALs) that have been treated are revisited periodically after the treatment operations have ended. This is particularly important for containing reinvasions by aggressive colonisers and for species, such as *Chromolaena odorata* and *Solanum mauritianum* which have persistent seed banks (Witkowski and Wilson 2001; Witkowski 2002; Witkowski and Garner 2008).

There are numerous other factors which should be taken into account when prioritizing areas to clear at the scale of a protected area, including site and location related factors and species attributes (notably the availability of biocontrol) (Roura-Pascual et al. 2009). It is also important to consider the invasions in the vicinity of the Reserve and the willingness of the adjacent communities to clear invasive alien plants on their land. This is why the mapping of the Reserves was extended to include a 1km wide buffer zone adjacent to the boundary of the Reserve.

6.2 Specific context of the reserve

This section is based on an assessment of the specific situation in and around the reserves and the species and their distribution in it. There are basically two ways of approaching the prioritisation of control operations in an area: species-based or area-based. In some cases the two can be combined to provide a more effective strategy (e.g. Van Wilgen et al. 2007; Roura-Pascual 2009). Since the treatments target all species in an area (NBAL), a species-based prioritisation also results in the complete clearing of areas. Species-based prioritisation is usually used to identify the most aggressive species or the one with the greatest impacts. Area-based prioritisation targets control operations at species rich, threatened or particularly sensitive communities or habitats.

Species-based prioritisation

Based on the mapping done for the reserves and other information (Versfeld et al. 1998; Henderson 2001), the most important invading species on the Wild Coast are:

- *Caesalpinia decapetala* – Mauritius thorn; an aggressive invader; apparently well-dispersed, the most probable dispersers are monkeys, baboons and antelope (and domestic livestock) which eat the pods and/or seeds; it is able to invade both disturbed and relatively intact forests as well as grasslands; a vigorous sprouter after fire;
- *Solanum mauritianum* – bugweed; an aggressive invader; dispersed by birds and monkeys which eat the fruit; seed banks accumulate in the ground and seeds can persist for years; it is able to invade disturbed forests and forest ecotones as well as grasslands with woody plant encroachment which provides bird perches; does not resprout after fire.

- *Cestrum laevigatum* – inkberry; an aggressive invader; very similar in its invasion ecology to bugweed; seed bank dynamics apparently unknown; invades grasslands and forest ecotones but not forest interiors as well as grasslands with woody plant encroachment which provides bird perches; does not resprout after fire.
- *Lantana camara* – lantana; an aggressive invader; very similar in its invasion ecology to bugweed; seed bank dynamics apparently unknown; able to invade a wide range of habitats; vigorous resprouter.
- *Chromolaena odorata* – triffid or paraffin weed; an aggressive invader; produces large quantities of wind dispersed which can cover considerable distances (kilometres); seed banks accumulate in the ground and seeds can persist for years; invades grasslands and forest ecotones but not forest interiors; established plants resprout vigorously after fire, saplings younger than one year killed by fire and fires at intervals of 3 years or less can keep *Chromolaena* out of grasslands.
- *Psidium guajava* – guava; an aggressive invader which produces abundant, edible fruit with large numbers of viable seeds; attracts birds, monkeys and other vertebrates capable of dispersing the seeds; invades grasslands, shrubby vegetation, woodlands and forest edges, essentially anywhere the seedlings can establish; even small plants are vigorous sprouters and it can persist even with frequent fires. The edible fruit of this species is used by local communities which may result in conflicts of interest about their control.

These species are all major invaders and have varying but similar impacts on the habitats they invade. One way of deciding on priorities is to use the ability to disperse as a criterion. *Chromolaena* has the potential to disperse the furthest and thus has the potential to spread into protected areas from outside as well as within a protected area and so would get priority under this rule. Another option - provided an effective biocontrol agent (or agents) is present and effective, or is available and can be introduced – is to give priority to the species without effective biocontrol. Detailed information on biocontrol is available and an indication of the availability of agents is given in Appendix 1.

Area-based prioritisation

The current mapping covers areas both inside and outside the Reserve. There are two reasons for including the areas outside:

- To identify potential source areas for species invading the Reserve, particularly for species that are dispersed and invade down streams or rivers. Wherever possible, as indicated under the principles above, upstream source areas should be cleared before starting on the downstream invasions; this includes areas outside the protected area provided their extent is sufficiently small to enable them to be cleared. If this is not possible then the riparian areas will simply have to be cleared regularly and repeatedly.
- To identify sources of species that are well enough dispersed (e.g. *Chromolaena odorata*) to recolonise the Reserve repeatedly if they are not cleared. In this case we

have identified a 1 km buffer zone where such species should be cleared. The primary target areas for non-riparian invasions are within the Reserve and clearing outside should be given a low priority until the internal invasions have been controlled.

6.3 Resources

The resources available have to be determined from the budgets, manpower and equipment that are provided, or are available on, Mkhambathi. They also have to take into account the co-management arrangements with the local communities and the training needs and the training available from WfW, and its service providers, for the community members who will comprise the control teams. Since WfW have already had teams working in the Reserve, one option would be to revive these teams where they are no longer employed; another option would be to take over teams where they are still active.

7 Monitoring and Evaluation

Monitoring and evaluation are critical inputs for improving the effectiveness of management both for specific activities (e.g. invasive alien plant control) and for overall management of the protected area. This requirement is specifically identified in the SMP under KRA 2 and KRA 7 as summarised above. In the case of KRA 7 the reserve management must ensure that key baseline and monitoring information on the implementation of the invasive alien and invasive species control programme is maintained. The information on the current state of invasions in section 4, and the greater detail provided in the GIS data from the mapping, provide a baseline for future assessment of progress.

7.1 Basics of adaptive management

Adaptive Management is an approach to the management of natural resources and organisations which places a strong emphasis on taking action, measuring their outcomes and effectiveness, adapting and improving the way in which actions are taken. The management and control of invasive alien plant species is not a process that can be precisely prescribed because there are too many events which require managers to continually alter their plans. Adaptive management recognizes this need for flexibility but combines it with a rigorous approach to documenting what happened and what decisions were taken to address the situation. Without this process of recording and reflection, we fail to learn from our mistakes or unforeseen events and are highly likely to fall into the same traps in the future. It is “*a way of incorporating reflection into action- to enhance the practice of conservation and learning*” (Berkes and Folke 1998). The process links indicators to project goals, objectives and management activities as opposed to considering indicators on their own. The advantage of this approach is that it emphasises the learning aspect of monitoring and evaluation. Managers must be willing to change, not too over-burdened to take the time to learn, and they must see willingness to change as being as important as action (Stem et al. 2005).

An important application of adaptive management is to improve the quality of goals and objectives that guide management. It is important to revisit goals and objectives regularly to determine if they are appropriate or need to be revised to make them more clearly defined, measurable, and useful for future management purposes (Pomeroy et al. 2004). In addition, indicators of success should be clearly linked to programme goals, objectives and activities. Only when managers recognise shortcomings in the cycle can they make adjustments that will, if correctly addressed, ultimately lead to more effective conservation action taking place.

A useful approach, which is being applied in the development of the fire management strategy, is the use of Thresholds of Potential Concern (TPC) (Biggs and Rogers 2003; CSIR 2008; Foxcroft 2009). This approach is based on setting upper and lower limits for a particular variable that is monitored so that action only needs to be taken when a threshold is likely to be, or has been, exceeded. For example, the percentage reduction in the density of an alien plant species following a particular treatment as specified in the NBAL contract (see section 7.3). As long as the reduction is within those limits there is no need to take action, but where it exceeds a limit then the manager must determine why this is the case and take action to correct the situation. The TPCs themselves are subject to change as people refine them based on their experience in applying them.

7.2 Working for Water Procedures

The Working for Water programme's procedures for implementing and managing a clearing project, and individual contracts within that project (WfW 2007), are a sound basis to work from. They cover the following steps:

- Project operational planning and administration
- Contract and treatment area administration
- Project contractor administration
- Management of transport, tools, equipment, stores, workshops
- Control methods, herbicides, use of fire, environmental awareness, health and safety
- Fire fighting and protection
- Social development, employment, training, participation of workers
- Costing

The procedures also include a basic set of reporting forms for the manager to use to document and monitor project progress and effectiveness. Some of these steps are described in section 8 below. They have not been detailed in this plan because the ECP need to decide whether they will adopt the full project management procedures and systems used by WfW or will customize them. This plan focuses on primarily on those specifically relating to the control operations and assessing their effectiveness.

7.3 Monitoring and evaluation of control treatments

There are different levels at which monitoring and evaluation of the control operations is carried out (CSIR 2008). The most important at the Reserve level are:

- MUCP level which assesses whether the overall progress is satisfactory when compared with the 5-year objectives that were set for this plan and with the targets set for the Annual Plan of Operations.
- The treatment unit (NBAL) level which assesses the effectiveness of the control treatments.

The top level of reporting is based on aggregating the assessments done at the treatment unit level and comparing the summarised actual progress with the planned progress. Where there are deviations from the planned outcomes the reasons for these should be evaluated and appropriate remedial actions taken. **These assessments and actions are the responsibility of the Reserve Manager.**

At the NBAL level the following monitoring and evaluation needs to be done for each treatment of that NBAL:

- Ensure that the NBAL boundaries are clearly defined and shown on the map and understood by the team.
- Ensure that the species composition and density and other information complies with the National Mapping Standards (WfW 2002) and the recommended treatments (see WfW Undated b).
- Ensure that the contract (agreement) with the team clearly stipulates the norms and standards of work that are expected (e.g. all stumps to be herbicide treated).
- Photograph the NBAL from some fixed points and mark those points on the map of the NBAL, describe the camera settings, time of day and direction in which the photographs were taken. A GPS can be used to locate these points but a permanent marker is preferred as GPS accuracy is generally a circle of at 5-10 m diameter around the actual point.
- Assess progress during the course of the treatment to ensure that it's as expected. Take action where progress is not satisfactory; document these actions.
- When the treatment has been completed inspect the NBAL to ensure it complies with the standards. Record the assessment on the Quality Control Form (WfW 2007). If not, take actions to ensure that it is brought up to standard. Photograph the outcome including repeating the fixed point photographs.
- Determine whether any rehabilitation measures need to be applied and, where necessary, take action to ensure that appropriate measures are taken to stabilise soils, minimise erosion and undertake active rehabilitation with indigenous plant species.
- If rehabilitation measures are taken they need to be described and photographed before and after.

A subset of the fixed point photographs of NBALs should be selected and regularly (i.e. annually) re-photographed to provide a long-term record of the outcome of the control operations. In addition to this there need to be regular assessments of the effectiveness of biocontrol agents on their host species as prescribed by and agreed with the regional WfW biocontrol implementer.

The responsibility of the Regional (Area) Manager should be check on at least 10% of the Reserve Manager's assessments and certify that the standards in the relevant contracts have been met.

At the project level, the project manager needs to ensure that monitoring of the effectiveness of the biocontrol agents is maintained, that agents are reintroduced where they are not having the desired impact, and that new agents are introduced as they become available.

7.4 Mapping approach

Working for Water have clearly defined and widely used standards for mapping of invasions which are aligned with their planning and budgeting procedures (WfW 2002; see sections 5 and 7). These standards are mainly applied in delimiting areas and defining the species composition and density for negotiating contracts with contractors. However, they can also be used for longer term planning with some assumptions about the resources available and the effectiveness of the control treatments. The current state of invasions of the Reserve has been mapped using these standards by Conservation Support Services (Pty) Ltd. A summary of this information is provided in section 3.1 and has been used to propose priorities for the next 5 years beginning in 2010/11.

8 Involving local communities

The ECP policy on involving local communities includes the following principles:

- *ECP will work with and co-operate with neighbouring communities and with other agencies and organs of state in the monitoring, control and eradication of invasive species, such as the SANBI, DEAT, DWAF, DEDEA, Ezemvelo KZN Wildlife, CapeNature, SANParks and municipalities.*
- *ECP may appoint implementing agents to assist with the monitoring, control and eradication of alien and invasive species in and around the reserves.*
- *Where possible, removal of alien and/or invasive species will be done in an economically advantageous manner, e.g. sale of timber, commercial hunting etc., in line with the Public Finance Management Act, in order to contribute to ECP goals of improving financial sustainability.*

The ECP and WfW are both required to engage with, and involve, local communities in their activities. Working for Water have the approaches, procedures and expertise necessary to involve local communities in control programmes and to seek opportunities for the beneficial uses of plant material obtained from the control operations. The co-management structures established with the local communities around each of the ECP protected areas should be used to get these communities involved in invasive alien plant control.

The ECP, as an implementing agent for WfW, will have access to the WfW expertise and resources, as well as the training courses, and should make full use of them. The ECP also need to decide at whether they will establish structures to facilitate co-operation with other agencies and local authorities (see the first bullet above) at a provincial, regional or reserve level.

9 Legal background and requirements

There are two pieces of legislation which are relevant to the control of invasive alien (plant) species:

- Conservation of Agricultural Resources Act (No. 40 of 1983) (CARA)
- National Environmental Management: Biodiversity Act (No. 10 of 2004) (NBA)

Both of these acts deal with weeds and their control which has led to some confusion because the jurisdiction and legal scope of these two Acts is still in the process of being finalized. CARA falls under the National Department of Agriculture and has regulations which define different categories of weeds and where and when they need to be controlled as well as the degree of control that needs to be exercised. Regulations for the implementation of the NBA clauses on invasive alien plants have been drafted and published for comment but they have not been promulgated and so cannot be legally enforced. Until such time as they are, the CARA regulations are the only ones with legal standing. A copy of the CARA regulations together with useful information on control and potential contacts are given in a very useful handbook compiled by Henderson (2001).

9.1 CARA and the applicable regulations

The Conservation of Agricultural Resources Act (CARA) falls under the jurisdiction of the Department of Agriculture. Most of the provisions of the Act relate to the management and control of agricultural (crop) weeds on cultivated lands and pastures but it has also been used in conservation areas. Detailed provisions are provided in the regulations (Department of Agriculture No. R280, 30 March 2001) which deal with control and prevention measures and define various categories of weed species in terms of their control and conditions for their use:

- *Category 1 plants may not occur on any land or inland water surface other than in biological control reserves*
- *Category 2 plants may not occur on any land or inland water surface other than a demarcated area or a biological control reserve*
- *Category 3 plants shall not occur on any land or inland water surface other than in a biological control reserve*

In the case of Category 3, previously existing plants do not need to be controlled provided that they are not within 30 meters of the 1:50 year flood line of a watercourse, lake, dam or

wetland. No new plants of these species may be imported, bought or sold, propagated or planted. This Act does not provide any specifications for management plans.

9.2 Biodiversity Act provisions

The revised draft regulations were published in the Government Gazette, No. 32090, 3 April 2009. They have not been published yet to this explanation is provisional and may have to be amended once the final version has been published.

The current wording of these regulations delegates the powers for their enforcement to the provincial government and the Member of the Executive Council responsible for environmental matters. The regulations list invasive plant species as well as species in other taxonomic groups which are divided into exempted, prohibited and invasive species.

The regulations provide for the preparation of management and control plans in regulation 9:

“Invasive species monitoring, control and eradication plans:

9(2) Every organ of state and every management authority of a protected area must prepare a plan for the monitoring, control and eradication of invasive species in terms of section 76(2)(a) of the Act.

9(3) Not applicable to ECP protected areas

9(4) An invasive species control plan prepared in terms of subregulation (2)...must

(a) comply with

- (i) guidelines published in terms of subregulation (1);*
- (ii) the national biodiversity framework published in terms of section 38(2) of the Act;*
- (iii) the norms and standards determined in terms of section 9 of the Act; and*
- (iv) the national strategy in terms of subregulation (7)*

(b) take account of any plan prepared by any other organ of state or management authority of a protected area in terms of any other legislation to prevent, eradicate or control alien or invasive species in the area under its jurisdiction

(c) have separate sections dealing with marine species, plants, vertebrates, invertebrates and microbes;

(d) include the following information-

- (i) the area of jurisdiction of the organ of state or management authority;*
- (ii) the land within the area of jurisdiction to which the plan or strategy relates;*
- (iii) a detailed list and description of any listed prohibited species or restricted species prioritized for prevention in the national strategy occurring on that land;*
- (iv) a description of the parts of that land that are infested with such prohibited or restricted species;*
- (v) an assessment of the extent of such infestation;*

- (vi) *the prioritization for control of the different areas of the land that are infested;*
- (vii) *the prioritization for control of the different species occurring on the land;*
- (viii) *the current and proposed measures to monitor, control and eradicate such prohibited or restricted species;*
- (ix) *the rehabilitation measures to be adopted; and*
- (x) *an estimate of the costs of implementing the measures;*
- (e) *contain an annexure with the following information-*
 - (i) *the proposed timetable for implementing the measures detailed in the invasive species control plan; and*
 - (ii) *measurable indicators of progress and success with implementing the measures; and*
- (f) *contain a record of all research into any aspect of the invasiveness of an alien or listed invasive species or the prevention, eradication or control of such invasiveness being undertaken on behalf of the organ of state or management authority.*

9(5) *The information contained in paragraph (e) of subregulation (4) must be captured in a representative manner on topographical maps or aerial photographs of the land.*

9(6) *An invasive species control plan referred to in subregulation (2) must be prepared within one year of the publication of the guidelines referred to in subregulation (1).*

9(7) *A copy of the invasive species control plan referred to in subregulation (2) or (3) and the maps or aerial photographs referred to in subregulation (5) must be lodged-*

- (a) *in the case of a municipality, with the provincial conservation authority; and*
- (b) *in the case of any other organ of state or management authority, with the Department.*

9(8) *Is only applicable to amendments*

9(9) *The organ of state or management authority preparing a plan in terms of subregulation (2) must-*

- (a) *implement the plan;*
- (b) *no later than every five years review the plan and the progress with the implementation; and*
- (c) *following on from the review, submit to the provincial conservation authority or the Department as the case may be-*
 - (i) *a report on progress with the implementation of the plan; and*
 - (ii) *any amendments to the plan.*

The Institute referred to above is the National Biodiversity Institute and the Department is the Department of Environment Affairs & Tourism.

The plan continued in this document, and the Annual Plans of Operations that will be prepared for Mkhambathi, must meet the requirements of the Act as set out above. A summary of the availability of chemical and biological control agents is given in Appendix 1 and a summary of information sources is given in section 9.

9.3 Other laws

There are other laws with provisions relating to invasive alien plants but they are not applicable to protected areas. A law that is important for invasive alien plant control is the Occupational Health and Safety Act and regulations under this act. This Act and the supporting regulations provide for specifications on the safe use and disposal of herbicides and the training and safety requirements for those who apply herbicides. It also covers safety equipment and operating procedures. Any of the control team members who have to deal with herbicides will require training in terms of this act to ensure that the ECP is properly covered in the event of any injuries on duty. The issue of ensuring that the necessary training is provided and completed is covered under KRA 6 of the Strategic Management Plan.

10 Sources of information

There are many sources of information on alien plant species control covering strategies, prioritisation, planning, control methods and a variety of other aspects. The section below lists key links to local information as this is the most relevant for control operations in South Africa. Additional sources are provided in the References (section 10).

Biological control

Information about the biological control (biocontrol) options available for various plant species can be obtained from the following sites:

PPRI - <http://www.arc.agric.za/home.asp?pid=902> (Plant Protection Research Institute)

WfW - <http://www.dwaf.gov.za/wfw/Control/>

The websites also provide contact information and links to additional sources of information on biological control. A summary of basic information on biological control for each of the species mapped in the protected areas is given in Appendix 1.

Control methods for specific species or groups of species

Information about the mechanical and chemical control options available for various plant species can be obtained from the following sites:

PPRI - <http://www.arc.agric.za/home.asp?pid=902>

WfW - <http://www.dwaf.gov.za/wfw/Control/>

A summary of basic information on the availability of chemical control for each of the species mapped in the protected areas is given in Appendix 1.

Training in alien plant species control

The PPRI offer a training course in weed control which is designed for people starting a career in controlling alien invasive plants. Completion of the first two modules enables the person to register as a Pest Control Officer which qualifies them to apply pesticides and herbicides in the environment as well as providing the necessary safety training. This qualification is required for the person to be able to use pesticides/herbicides and meet the requirements for protection in terms of the Occupational Health & Safety Act.

Information about the course is available from the following website:
<http://www.arc.agric.za/home.asp?PID=1004&ToolID=62&ItemID=2903>

11 Research

It is good management practice to develop, implement, and maintain a relevant and focused research and monitoring program for the reserve. The subject matter for that research and monitoring programme can include: invasive alien clearing, vegetation monitoring, game counts, resource use activities, visitor numbers and profiles and an illegal activity register. The development of more effective methods of monitoring and assessing changes should have a high priority. The range of subjects is open ended and the choice of subjects would depend on the issues and questions identified by the manager and the teams conducting the control operations. The identification of these issues should be part of the management process and they should be communicated to ECP scientific services, Working for Water, or the PPRI through the appropriate channels so that they can be investigated. Examples include:

- How to prioritise weed control (e.g. by species or areas or both) to achieve effective control and maximise efficiency
- Failure of a biocontrol agent to establish properly
- Failure of a control treatment e.g. a high percentage of regrowth following herbicide application to a particular species
- How to use fire in the weed control operations
- Appearance of a new weed species that needs identification

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Appendix 1. A summary of the availability of biological control agents and chemical control prescriptions for the invasive alien plant species recorded during the mapping of the protected areas. For details of the actual agents and of the chemical treatments available see section 9 and the links provided there, particularly the information available from the Working for Water website. This information should be updated regularly based on inputs from the WfW regional biocontrol implementation manager.

| No | Species | Common name | Biocontrol available [#] | Chemical options [#] | Fire use |
|----|-----------------------------|----------------------------|-----------------------------------|-------------------------------|--|
| 1 | Acacia baileyana | Bailey's wattle | | | Fire can be used to stimulate seed germination for follow-up |
| 2 | Acacia longifolia | Long-leaf wattle | y | y | Fire can be used to stimulate seed germination for follow-up |
| 3 | Acacia mearnsii | Black wattle, Iwatlisi | y | y | Fire can be used to stimulate seed germination for follow-up |
| 4 | Agave sisalana | Sisal, Ikhala | | y | Can be killed by fire |
| 5 | Ageratum conyzoides | Ageratum | | | Unknown |
| 6 | Araucaria spp. | Monkey puzzle tree | | | Fire resistant, not recommended |
| 7 | Arundo donax | Spanish reed | | | Resprouts vigorously, fire can be used to clear thickets to facilitate entry |
| 8 | Asclepias physocarpa | | | | Unknown |
| 9 | Bambusa vulgaris | Bamboo | | | Resprouts vigorously, fire can be used to clear thickets to facilitate entry |
| 10 | Bidens pilosa | Black jack, Ugcadolo | | | Unknown |
| 11 | Caesalpinia decapetala | Mauritius thorn, Ubobo | y | y | Resprouts vigorously, fire can be used to clear thickets to facilitate entry |
| 12 | Callistemon spp. | Bottlebrush | | | Resprouts vigorously, not recommended |
| 13 | Canna indica | Canna, Unomatananga | | | Resprouts vigorously, not recommended |
| 14 | Carica papaya | Pawpaw | | | Unknown, may resprout |
| 15 | Cassia / Senna didymobotrya | Peanut-butter senna | | y | Can be killed by fire |
| 16 | Casuarina cunninghamia | Beefwood | | y | Can be killed by fire |
| 17 | Catharanthus roseus | Madagascar periwinkle | | | Unknown |
| 18 | Cereus jamacaru | Queen of the night cactus | y | y | Unknown, capable of vegetative reproduction |
| 19 | Cestrum laevigatum | Inkberry | | y | Resprouts vigorously, not recommended |
| 20 | Chromolaena odorata | | y | y | Resprouts vigorously, fire can be used to clear thickets to facilitate entry, annuals can prevent seedling recruitment but longer intervals facilitate establishment |
| | | Paraffin weed | | | be a fire hazard |
| 21 | Cirsium spp. | Thistle, Ikhakhakhaka | d | | Unknown |
| 22 | Convolvulus arvensis | Wild morning glory, Ubhoqo | | | Likely to reproto strongly |

| No | Species | Common name | Biocontrol available [#] | Chemical options [#] | Fire use |
|----|-------------------------|------------------------------|-----------------------------------|-------------------------------|--|
| 23 | Cortaderia spp. | Pampas grass | | | Resprouts vigorously, fire can be used to clear thickets to facilitate entry |
| 24 | Datura spp. | Thorn apple, Ingqangangqanga | | | Unknown, persistent seedbank |
| 25 | Eucalyptus spp. | Bluegum | | y | Resprouts vigorously, not recommended |
| 26 | Grevillea robusta | Silky oak | | | Unknown, fire tolerant? |
| 27 | Hedychium spp. | Ginger | | | Resprouts vigorously, not recommended |
| 28 | Ipomoea spp. | Morning glory, Imbotyi | | | Unknown |
| 29 | Jacaranda mimosifolia | Jacaranda | | y | Resprouts, not recommended |
| 30 | Lantana camara | Lantana, Utywala bentaka | y | y | Resprouts, fire can be used to clear thickets to facilitate entry |
| 31 | Leptospermum laevigatum | Australian myrtle | y | y | Killed by fire which releases seeds |
| 32 | Melia azederach | Syringa, Umsalenge | | y | Resprouts, not recommended |
| 33 | Montanoa hibiscifolia | Tree daisy | | | Unknown |
| 34 | Nephrolepis exaltata | Sword fern | | | Unknown |
| 35 | Opuntia spp. | Prickly pear, Ugasgom | d | d | Unknown, capable of vegetative reproduction |
| 36 | Passiflora subpeltata | Granadilla | | | Unknown, may resprout |
| 37 | Phytolacca octandra | Inkbush, Umnanja | | | Unknown |
| 38 | Pinus spp. | Pine | | t | Fire tolerant, releases seeds, not recommended |
| 39 | Plectranthus comosus | Woolly plectranthus | | | Resprouts? |
| 40 | Plumeria spp. | Frangipani | | | Unknown |
| 41 | Psidium guajava | Guava | | | Resprouts vigorously, fire can be used to clear thickets to facilitate entry |
| 42 | Ricinus communis | Castor-oil bean, Umhlavutha | | y | Fire can be used to stimulate seed germination for follow-up |
| 43 | Rubus spp. | Bramble | | y | Resprouts vigorously, fire can be used to clear thickets to facilitate entry |
| 44 | Senna spp. | Senna/Cassia | | | May sprout after fire |
| 45 | Sesbania punicea | Red sesbania | y | y | Killed by fire, seeds not stimulated by fire |
| 46 | Solanum mauritianum | Bugweed, Umbangabanga | y | y | Fire can be used to stimulate seed germination for follow-up |
| 47 | Solanum spp. | Impehla | d | | Unknown |
| 48 | Tithonia diversifolia | Mexican sunflower | | | Can form fire-resistant clumps |

[#]: y = available, d = depends on the actual species present.