

## **An annual cycle of review and planning for weed management by a mining company in Northern Australia**

Cherie Gellert

Energy Resources of Australia Ltd, GPO Box 2394, Darwin, NT 0801, Australia  
(cherie.gellert@era.riotinto.com)

**Summary** Energy Resources of Australia Ltd (ERA) is a mining company operating in Northern Australia which is committed to protecting the surrounding environment. ERA has developed a Five-Year Weed Management Plan which contains seven Aims and associated Targets, designed to enable ERA to meet its overall objectives for weed management. Annual One-Year Weed Management Plans (1YWMP) then contain the specific Actions that need to be undertaken by ERA in the calendar year in order to meet the seven Targets. To assist in planning and recording data ERA's lands have been divided into Weed Management Areas (WMA) based on the track network, amenity, natural land features and land use. ERA has a Weed Control Prioritization Procedure which is used to rank each of the WMA annually using the data from annual weed mapping. The criteria that are scored for the ranking are risk of weed spread by traffic, phase of invasion, risk of weed spread by water, and proximity of infestations to sensitive areas. Fine-scale mapping of weeds on the ERA lands has been undertaken annually since 2003 to assist ERA to assess the effectiveness of weed control, provide information for prioritisation and planning, and identify new weed infestations. Once the data from the annual weed mapping is compiled and analysed a workshop is held to plan for the following year's weed management and develop the 1YWMP. The 1YWMP includes details of the control methods to be used, timing of control, areas and species to be targeted, allocation of resources, prioritisation rankings, and which WMA will be surveyed in the next annual weed survey. Thus an annual cycle of Plan-Do-Check-Review is in place which is in line with the ISO14001 environmental management system's continual improvement cycle.

**Keywords** Weed management, planning, review, targets, continual improvement.

### INTRODUCTION

Energy Resources of Australia Ltd. (ERA) operates the Ranger Uranium Mine on the Ranger Project Area (RPA), and manages the adjacent Jabiluka Mineral Lease (MLN1) under a long-term care and maintenance agreement. The total combined area of the RPA and MLN1 is approximately 15 000 hectares. The RPA

and MLN1 are located near the town of Jabiru, in the Alligator Rivers Region of the Northern Territory, and are surrounded by but separate from the World Heritage listed Kakadu National Park (KNP). ERA is committed to protecting the surrounding environment, in particular to maintaining the cultural and environmental attributes for which KNP was inscribed on the World Heritage list. Weeds are a significant threat to KNP's ecosystems and have the potential to impact on those criteria (Kakadu Board of Management 2007). There have been 120 exotic plant species recorded in KNP, representing less than 8% of the total plant species in the park. This compares favourably to other conservation reserves in Australia, which have an average of 21% exotic plant species (Hunter *et al.* 2010). On the RPA and MLN1 there have been 82 exotic plant species recorded since 2003, however only 50 species were present in 2011 (Gellert and McIntyre 2011). ERA is legally obligated to ensure that it does not introduce any exotic flora into KNP. Also, the presence of weeds in the RPA and MLN1 could impact on the ability of ERA to adequately rehabilitate the areas so that they can be integrated into KNP following mine closure. Therefore weeds represent a significant environmental risk to ERA, and weed management is a high priority (Gellert 2011).

### THE FIVE-YEAR PLAN

ERA has been building on and improving its weed management system and processes over the last decade. In order to further improve coordination and formalise the weed management system ERA decided in 2011 to replace its previous weed plan with a Five-Year Weed Management Plan (5YWMP). The 5YWMP was developed in accordance with the guidelines provided in Section 10 of the *NT Weed Management Act 2001*, applies to all exotic species on the RPA and MLN1, and covers the period from January 2012 to December 2016. The 5YWMP describes the objectives and aims of ERA's weed management and provides an overview of ERA's weed management activities. A key component of the 5YWMP was the development of seven weed management targets which are both specific and measurable.

ERA's lands have been divided into 48 Weed Management Areas (WMA) based on the track network, the amenity of the area, natural land features and land use, in order to assist in planning management and recording data. Some of the WMA have been classified as Weed Quarantine Areas (WQA) or Weed Protection Areas (WPA). WQA have been identified as having a high weed infestation and they are managed to prevent spread of weeds out from them, while WPA have been identified as having a very low level of weed presence and they are managed to prevent spread of weeds into them (Gellert 2011). Fine-scale weed mapping has been conducted annually on the RPA and MLN1 since 2003 (Gellert 2010). This allows ERA to know both the spatial extent of priority weeds (the 13 species which are mapped) and the number of introduced species on the RPA and MLN1 each year. The 13 priority species are *Calopogonium mucunoides* Desv., *Chamaecrista rotundifolia* (Pers.) Greene, *Crotalaria goreensis* Guill. & Perr., *Hyptis suaveolens* (L.) Poit., *Ipomoea quamoclit* L., *Macroptilium atropurpureum* (DC.) Urb., *Pennisetum pedicellatum* Trin., *Pennisetum polystachion* (L.) Schult., *Senna obtusifolia* (L.) H.S.Irwin & Barneby, *Sesamum indicum* L., *Sida acuta* Burm.f., *Sida cordifolia* L. and *Themeda quadrivalvis* (L.) Kuntze. The annual weed survey is discussed in more detail later in this paper.

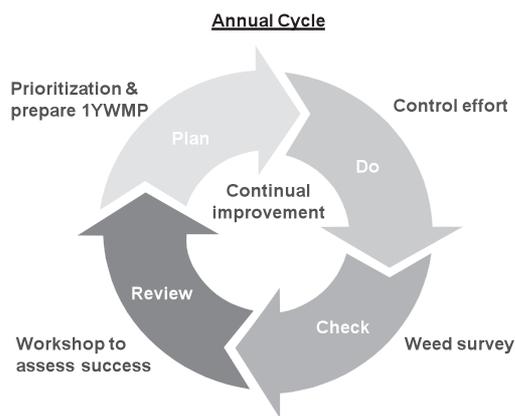
Each of the targets in the 5YWMP can be assessed using the WMA classification and the data from the annual weed survey. The targets reflect the diverse aims of preventing introduction of new weed species, elimination of species when feasible, protection of areas that are weed-free, elimination of small infestations, reduction of moderate infestations, containment of large infestations, and protection of KNP. In the past a focus on reducing total weed-infested area had resulted in less emphasis being placed on the other aims, such as elimination of small infestations. Therefore it was decided to have an equally-weighted target for each aim, to increase the likelihood of multiple aims being met. This is particularly important when the targets are used for setting the objectives for performance assessment of ERA personnel who are involved in weed management.

The seven targets in the 5YWMP are:

- A. No new species recorded on the RPA or MLN1
- B. Decrease in the number of species recorded on the RPA and MLN1
- C. No increase in the mapped weed area of WMA that surround the WQA
- D. Decrease in the number of discrete infestations per WMA (excluding WQA)
- E. No weeds located within 250 m of the lease boundaries or water courses which exit the leases

- F. Decrease in the area of mapped weeds on the RPA and MLN1
  - G. No increase in the mapped weed area of WPA.
- These targets are to be achieved over the 2012–2016 period.

Progress towards the targets is supported by a set of specific actions, the details of which are described in annual One-Year Weed Management Plans (1YWMP). While the targets remain the same from year to year, the actions are revised annually. This is achieved through an annual cycle of weed management following a Plan, Do, Check, Review structure.



**Figure 1.** The annual Plan-Do-Check-Review cycle of weed management at ERA.

#### THE ANNUAL CYCLE

**Plan** The 1YWMP contains the specific actions that need to be undertaken in that year by ERA personnel in order to meet the targets contained in the 5YWMP. For example in order to meet target B an action may be to eradicate a particular species which is so far only present in one WMA. The 1YWMP includes details of the control methods to be used, timing of control, areas and species to be targeted, allocation of resources and prioritisation of WMA. Generally weed management is planned at the WMA scale, rather than by individual infestations, however actions may be aimed at particular infestations. Each year the Weed Control Prioritisation Procedure is used for prioritisation of WMA by scoring them against the following criteria:

- i. Risk of weed spread *via* traffic (proximity of infestations to roads and tracks)
- ii. Phase of invasion
- iii. Risk of weed spread *via* water (proximity of infestations to drainage lines)

- iv. Proximity of infestations to sensitive and/or high value areas (such as the lease boundary, cultural sites and revegetation areas).

The final priority score allows WMA to be ranked and allocation of resources for weed control assigned appropriately. These priority rankings, the amount of control applied in the past, the effectiveness of the past control, and a knowledge of control requirements are used to allocate suggested amounts of control effort for each WMA in line with the total resources available (Gellert 2011). Expertise based on past weed control experience in the area is necessary for making accurate predictions of required control effort (Puig *et al.* 2010). However suggested amounts of control effort given in the 1YWMP are a guideline only, and the actual hours for a given WMA may exceed or fall under the suggested hours, depending on factors such as duration of the wet season, availability of resources etc. The actions in the 1YWMP may also include activities other than direct weed control, such as updating weed training resources or purchase of equipment. Each action is assigned to a responsible person and should be completed by the end of the year. The 1YWMP also determines which WMA are to be surveyed in the next annual weed survey.

**Do** The majority of ERA's weed control is by on-ground chemical application, however physical control is also commonly used, and in certain situations ERA will use fire for weed management. A record is maintained of all weed control activities by completing a Weed Control Log at the end of each day. Information recorded includes the date, operators, WMA, description of location, weed species, chemical used, time taken, and equipment used. Weed control is generally summarised as person-hours of control effort per WMA over each weed control season, which is typically between December and May (Gellert 2011). In the 2010–2011 weed control season ERA spent 3120 person-hours on weed control, of which 20% was spent on the MLN1 and 80% on the RPA (Gellert and McIntyre 2011). Time spent on the ground during the annual weed survey is included in the weed control effort, though data analysis and reporting are not. Other weed management activities which are not included in this figure include conducting inspections of vehicles and equipment for weed seeds, providing weed education and identification training to other ERA personnel, and supporting research into weed ecology. In particular ERA puts significant effort into weed quarantine and hygiene, and has a permit system that requires vehicles to be cleaned and inspected by environmental personnel before accessing WQA or WPA (Gellert 2011). While this is prevention activity

aimed at meeting targets A, C and G, it is not counted towards weed control effort.

**Check** The annual weed survey involves compiling a checklist of all introduced species observed in the field in each surveyed WMA and fine-scale mapping of 13 priority species. The mapping is accomplished using a GPS enabled palm-top computer with ArcPad (ESRI, California) software, which allows attributes (density, size, location and species composition) of individual weed infestations to be recorded electronically and quickly in the field. An ERA Standard Operating Procedure details the survey methodology and ensures consistency of data collection between operators and from year to year. For the sake of efficient and strategic use of survey resources, every WMA is not surveyed every year, with the survey frequency depending on the WMA's priority ranking. For example, 17 of the 48 WMA were surveyed in 2011. The survey data is used to produce maps of the spatial extent and density of priority weeds on the RPA and MLN1, and to calculate the weed area in each WMA and the percent change in weed area from the previous year for each WMA (Gellert and McIntyre 2011). The weed survey is labour intensive, typically taking two people four weeks. However use of remote sensing to survey the weeds on ERA lands is currently not feasible and would be limited to large infestations composed of particular species (Pfitzner *et al.* 2004) while ground based surveying allows the early detection of infestations in new areas or of new species. In the 2010–2011 weed control season the survey represented 6% of the total weed control effort. The weed survey data is used to measure progress against each of the seven targets and each year the previous year is used as the baseline e.g. number of species in 2012 will be compared against number of species in 2011 to check for increase or decrease for Target B. The weed survey data is presented in an annual report, along with a checklist of which targets have and have not been achieved (Gellert 2011).

**Review** Once the data from the annual weed mapping is compiled and analysed, a workshop is held, involving the scientists, managers, and control operators involved in weed management. The survey data is then used to assess the success of the previous year's weed management. The relationship between control effort and change in weed area in a WMA has been found to not be straightforward (Puig *et al.* 2010), and may be affected by other factors such as climate (long or short wet-season) or disturbance occurring in the area. Thus it is important for the review to utilise the knowledge and experience of subject matter experts.

The review of the weed survey data also provides guidance as to whether the control effort in each WMA needs to be increased, and where within the WMA the effort needs to be focused. During the workshop the weed survey data is also used to complete the Weed Control Prioritisation Procedure, and this then leads into planning the following year's weed management and development of the 1YWMP and associated actions (Gellert 2011).

#### DISCUSSION

A similar annual cycle for weed management could readily be adapted and adopted by other mine-sites or other land managers. The details of the weed management plans would differ, and the plan would be based on the particular aims and objectives of their weed management, however the overarching framework of the Plan, Do, Check, Review cycle is widely applicable. Such a cycle would be particularly suitable for organisations that are certified against the ISO14001: 2004 Environmental management systems standard, which is based on the Plan, Do, Check, Act methodology, and requires organisations to be committed to continual improvement. An annual cycle of review and planning for weed management, such as ERA's, conforms to the methodology of the ISO14001 standard and allows for continual improvement. It also conforms to the Plan, Manage, Measure, Evaluate cycle that is used for adaptive weed management (Dewey and Anderson 2004).

At ERA the total amount of person-hours spent on the Check, Review and Plan portions of the cycle is estimated to be less than 20% of the total person-hours spend on all weed management activities, with the bulk being spent on the Do part of the cycle. Thus it can be seen as a moderate investment that can lead to good returns through improvement of the efficiency and effectiveness of weed control. Theoretically this improvement will be annual and continuous, leading to better weed management outcomes each year.

#### ACKNOWLEDGMENTS

Thank you to the many ERA personnel who have contributed to the development of ERA's weed management system over the last decade. Particular thanks to Amber Hooke for her input into the 5YWMP, and to Gentry Carlow for being ERA's subject matter expert on weed control.

#### REFERENCES

- Dewey, S.A. and Andersen, K.A. (2004). Distinct Roles of Surveys, Inventories, and Monitoring in Adaptive Weed Management. *Weed Technology* 18, 1449-1452.
- Gellert, C. (2010). Fine-scale weed mapping of two mining leases in Northern Australia. *In Proceedings of the 17th Australasian Weeds Conference.* (Ed.) S. M. Zydenbos, 205-206 (New Zealand Plant Protection Society, Christchurch, New Zealand.).
- Gellert, C. (2011). 5-Year Weed Management Plan 2012–2016. Energy Resources of Australia Ltd report, December 2011.
- Gellert, C. and McIntyre, D. (2011). 'Annual Weed Survey of Ranger and Jabiluka 2011'. Energy Resources of Australia Ltd report, October 2011.
- Hunter, F., Ibbett, M. and Salau, B. (2010). Weed Management in Kakadu National Park. *In Kakadu National Park Landscape Symposia Series 2007–2009. Symposium 2: Weeds management.* (Ed.) S. Winderlich, 27–28 November 2007, Jabiru Field Station, Supervising Scientist Division, Kakadu National Park. Internal Report 565, January 2010, Supervising Scientist, Darwin, 22-28.
- Kakadu Board of Management (2007). Kakadu National Park Management Plan 2007-2014. (Director of National Parks, Australian Government).
- Pfützner, K., Bayliss, P., Welch, M. and Puig, P. (2004). Remote sensing for weed mapping at Ranger. Department of the Environment and Heritage, Supervising Scientist, internal report 496, December 2004.
- Puig, P., Carlow, G. and Gellert, C. (2010). Impact of Weed Management Effort on Mission Grass Infestation. EWL Sciences Pty Ltd report for Energy Resources of Australia Ltd, February 2010.