



Government of **Western Australia**
Department of **Environment and Conservation**

INTERIM RECOVERY PLAN NO. 313

Edgar Range Pandanus
(Pandanus spiralis var. flammeus)

INTERIM RECOVERY PLAN

2011-2016



September 2011
Department of Environment and Conservation
Kensington

FOREWORD

Interim Recovery Plans (IRPs) are developed within the framework laid down in Department of Conservation and Land Management (CALM) Policy Statements Nos. 44 and 50. Note: CALM formally became the Department of Environment and Conservation (DEC) in July 2006. DEC will continue to adhere to these Policy Statements until they are revised and reissued.

The plans outline the recovery actions that are required to urgently address those threatening processes most affecting the ongoing survival of threatened taxa or ecological communities, and begin the recovery process.

DEC is committed to ensuring that threatened taxa are conserved through the preparation and implementation of Recovery Plans (RPs) or IRPs, and by ensuring that conservation action commences as soon as possible.

This plan will operate from September 2011 to August 2016 but will remain in force until withdrawn or replaced. It is intended that, if the taxon is still ranked as Endangered (EN) this plan will be reviewed after five years and the need for further recovery actions assessed.

This plan was given regional approval on 13 February 2011 and was approved by the Director of Nature Conservation on 7 September 2011. The provision of funds identified in this plan is dependent on budgetary and other constraints affecting DEC, as well as the need to address other priorities.

Information in this plan was accurate at September 2011.

PLAN PREPARATION

This plan was prepared by Nick Casson¹ Val English² and Robyn Luu³

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ACKNOWLEDGMENTS

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Cover photograph by DEC.

CITATION

This plan should be cited as:

Department of Environment and Conservation (2011) *Pandanus spiralis* var. *flammeus* Interim Recovery Plan 2011-2016. Interim Recovery Plan No. 313. Department of Environment and Conservation, Western Australia.

SUMMARY

Scientific Name:	<i>Pandanus spiralis</i> var. <i>flammeus</i>	Common Name:	Edgar Range <i>Pandanus</i>
Family:	Pandanaceae	Flowering Period:	January to February
DEC Region:	Kimberley	DEC District:	West Kimberley
Shire:	Broome	NRM Region:	Rangelands
Recovery Team:	-	IBRA Region:	Dampierland

Illustrations and/or further information: Brown, A., Thomson-Dans, C. and Marchant, N. (Eds) (1998) *Western Australia's Threatened Flora*. Department of Conservation and Land Management, Western Australia; Western Australian Herbarium (1998-) *FloraBase – The Western Australian Flora*. Department of Environment and Conservation. <http://florabase.dec.wa.gov.au/>; Keighery, G.J. and Dixon, I.R. (1980) Screw pines (*Pandanus*) in Western Australia. *West Australian Nutgrowing Society Yearbook* 6, 42-47; Stone, B.C. (1983) A new Western Australian species of *Pandanus* subgenus *Pandanus* section *Semikeura* (Pandanaceae). *Nuytsia* 4(3), 427-434; Wheeler, J. R. (1992) *Flora of the Kimberley Region*. Department of Conservation and Land Management.

Current status: *Pandanus spiralis* var. *flammeus* was declared to be rare flora (DRF) under the Western Australian *Wildlife Conservation Act 1950* in 1989 and is ranked as Endangered (EN) in WA under International Union for Conservation of Nature (IUCN 1994) criteria C2a; D. However, ranking should be reviewed and updated to IUCN 2001 as there are now more than 250 mature individuals known (see recovery action 16). The taxon is listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999) as Endangered. The main threats to the taxon are grazing and trampling, altered fire regimes, weeds, feral animals, small population size and potentially poor genetic diversity, hydrological changes and lack of secure conservation tenure.

Description: *Pandanus spiralis* var. *flammeus* is a narrow trunked plant to 5 m high with aerial roots and bluish-green, spirally arranged, sword-like leaves that are 4 to 5 cm wide when mature. The pendulous fruits are made up of 16 segments which, when ripe, turn scarlet red and fall to the ground. Each segment contains up to six seeds (Brown *et al.* 1998). The relationship of these plants to a similar *Pandanus* approximately 180 km to the east in the St George's Ranges is currently unresolved taxonomically.

Habitat requirements: *Pandanus spiralis* var. *flammeus* is known from two populations at Logues Spring in the Edgar Ranges (Kimberley Region of WA). It is mainly restricted to a small, narrow gorge, growing in fine, white, dusty clay which becomes boggy when wet (Brown *et al.* 1998).

Habitat critical to the survival of the variety, and important populations: Given that *Pandanus spiralis* var. *flammeus* is ranked as EN, and only known from two confirmed sites, it is considered that all known habitat for wild populations is critical to the survival of the taxon. Habitat critical to the survival of *P. spiralis* var. *flammeus* includes the habitat of populations and areas of similar habitat surrounding populations (these offer habitat for population expansion and for fauna species that interact with the plants); additional occurrences of similar habitat that may contain undiscovered populations of the taxon (e.g. Jocelyn Valley, St George Ranges) or be suitable for future translocations; and the local catchment for the surface and/or groundwater that maintains the habitat of the taxon (especially localised gullies and springs).

Benefits to other species or ecological communities: Recovery actions implemented to improve the quality or security of the habitat of *Pandanus spiralis* var. *flammeus* will also improve the status of associated native vegetation and native fauna.

International obligations: This plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity ratified by Australia in June 1993 and will assist in implementing Australia's responsibilities under that convention. *Pandanus spiralis* var. *flammeus* is not listed under any specific international treaty however, and this plan does not affect Australia's obligations under any other international agreements.

Indigenous Consultation: A search of the Department of Indigenous Affairs Aboriginal Heritage Inquiry System has identified that the main *Pandanus spiralis* var. *flammeus* population is in the immediate vicinity of three culturally significant sites (ID Numbers 14397, 14398 and 14450); one of which has closed access. Input and involvement is being sought through the Kimberley Land Council, Department of Indigenous Affairs and the traditional owners of the area, the Njikená, to determine if there are any other issues or interests. The area containing the taxon does not appear to be part of contemporary Native Title negotiations. Consultation has been included as a recovery action to ensure there has been Indigenous engagement in relation to the recovery actions posed in this plan.

Social and economic impacts: *Pandanus spiralis* var. *flammeus* occurs on Dampier Downs which is an active pastoral lease. Population 1 is linked to a valley that retains spring moisture for much of the year and has value for stock watering. Management of stock access to the spring has economic impacts to the lessee.

Affected interests: The stakeholders potentially affected by the implementation of this plan include the indigenous parties (especially the Kimberley Land Council), the pastoral lease holder, government agencies, and conservation organisations.

Evaluation of the Plan's Performance: DEC will evaluate the performance of this plan. In addition to annual reporting on progress and evaluation against the criteria for success and failure, the plan will be reviewed following five years of implementation.

Existing Recovery Actions: The following recovery actions have been or are currently being implemented:

1. The lessee of Dampier Downes Station has been notified of the declared rare status of the taxon, its location and the associated legal obligations.
2. The Department of Fisheries and Wildlife undertook a biological survey of the Edgar Ranges between 1976 and 1980. The population of *Pandanus spiralis* var. *flammeus* was mapped and counted in 1980.
3. The recovery actions to date have been largely implemented and maintained by the lessee with some measures receiving financial and physical assistance from DEC and the Broome Botanical Society. These include the erection of a portable cattle barrier and the installation of a tank, pump, pipeline, pump and trough to supply water to stock away from the *Pandanus*.
4. Donkeys were present in large numbers until around 2000 when the Department of Agriculture and Food Western Australia removed 99% of the animals through the Judas program. Their removal would have aided recovery of the *Pandanus* and its habitat.
5. A population of a similar taxon in the St. George Range has been visited, but no fertile material was found to ascertain its relationship to *Pandanus spiralis* var. *flammeus*.
6. Seed collection was undertaken with six plants propagated and planted in the gardens of the DEC West Kimberley District office in Broome.

Plan Objective: The objective of this plan is to abate identified threats and maintain or enhance *in situ* populations to ensure the long-term preservation of the variety in the wild.

Recovery Criteria

Criteria for success: The number of populations has increased and/or the number of mature individuals has increased by ten percent or more over the term of the plan.

Criteria for failure: The number of populations has decreased and/or the number of mature individuals has decreased by ten percent or more over the term of the plan.

Recovery actions

- | | |
|---|---|
| 1. Establish a West Kimberley District Threatened Flora Recovery Team and coordinate recovery actions | 10. Monitor populations |
| 2. Rehabilitate habitat | 11. Undertake surveys |
| 3. Ensure long-term protection of habitat | 12. Develop and implement a fire management strategy |
| 4. Exclude stock and feral animals from the area of <i>Pandanus spiralis</i> var. <i>flammeus</i> | 13. Start the translocation process if necessary |
| 5. Undertake liaison with land managers and Indigenous groups | 14. Obtain biological and ecological information |
| 6. Investigate genetic diversity and confirm taxonomic status | 15. Map habitat critical to the survival of <i>Pandanus spiralis</i> var. <i>flammeus</i> |
| 7. Conduct weed control if necessary | 16. Review and update the ranking of <i>Pandanus spiralis</i> var. <i>flammeus</i> |
| 8. Collect seed | 17. Review this plan and assess the need for further recovery actions |
| 9. Undertake hydrological investigations | |

1. BACKGROUND

History

The first collection of *Pandanus spiralis* var. *flammeus* was made by K. Kenneally in August 1976. In 1992 G. Graham collected samples for the Kimberley Regional Herbarium at Kununurra.

The taxon is known from two populations at Logues Spring in the Edgar Range, south-east of Broome. These are within the active pastoral lease of Dampier Downs.

Population maps from 1980 to 2001 show a contraction in extent of the main population and a permanent loss of adults. There are no records prior to 1980 and the full extent of the population in the valley before then is unclear. The contraction apparently took place in two phases. First, from 1980 to 1989 when there was a loss of plants and clumps through the valley, but especially at the north of the population. In 1992 a dry season stock barrier was installed at the limit of the 'retreating' *Pandanus* by the lessee using a Government conservation grant. However, between 1992 and 2001 the barrier was moved further down the valley as the population continued to recede. As at 2001, the barrier appears to have omitted about 29% of 1980 *Pandanus* habitat, with the apparent loss of about 15 adults or clumps.

The last accurate mapping of *Pandanus spiralis* var. *flammeus* counted 106 adults. The number of adults has fluctuated and the number of dead adults at any time has also varied. Over time such loss has been progressive as plants fall over and the population retreats up the valley.

Description

Pandanus spiralis var. *flammeus* is a narrow trunked plant to 5 m high with aerial roots and bluish-green, spirally arranged, sword-like leaves 4 to 5cm wide when mature. Its pendulous fruits, which are made up of 16 segments, turn scarlet red when ripe. Each segment contains up to six seeds (Brown *et al.* 1998). It is distinguished from other varieties by its scarlet fruiting heads which are 13 cm long and wide and smaller than those of the typical variety (Brown *et al.* 1998). The relationship of *spiralis* var. *flammeus* to a similar *Pandanus* approximately 180 km to the east in the St George's Ranges is currently unresolved taxonomically.

Distribution and habitat

Pandanus spiralis var. *flammeus* is known from two populations on a Pastoral Lease at Logues Spring in the Edgar Ranges (Kimberley region of Western Australia). It is mainly restricted to a narrow gorge, growing in fine, white, dusty clay which becomes boggy when wet (Brown *et al.* 1998). See Appendix 2 for hydrology of Logues Spring.

Population 1 is in the upper half of a minor valley that is open to the adjacent plains. In this area the taxon occurs with *Eucalyptus papuana*, *Acacia holosericea*, *Atalaya hemiglauca* and *Clerodendrum* sp. and a mixed understorey comprising grasses and shrubs.

Population 2 is much further into the range in the bed of a deeply incised drainage line that is protected by sheer six metre high rock walls on both sides. There is little information on the associated plant assemblage at this population.

Table 1. Summary of population land vesting, purpose and manager

Pop. No. & Location	DEC District	Shire	Vesting	Purpose	Manager
1. Logues Spring	West Kimberley	Broome	Unallocated Crown land	Pastoral Lease	Lessee
2. Logues Spring	West Kimberley	Broome	Unallocated Crown land	Pastoral Lease	Lessee

Populations in **bold text** are considered to be important populations.

Biology and ecology

Fruit and seedlings have been observed on a number of occasions. A large number of root-shoots/suckers have also been observed at Population 1. Clonal reproduction by stolons is known to occur in *Pandanus spiralis* and

several other Australian species. It is possible that asexual reproduction by apomixis may also occur as it is common in the genus (Stone 1978, Thomson *et al.* 2006).

Pandanus seed is easily collected and germinates well with extremely rapid root development (Rowley 1993). Fresh seed is required for good germination as older seeds germinate erratically. The fruit needs to be broken into phalanges and these in turn into drupes, each containing one seed. It is the drupes that are planted. Sowing is in late spring to mid August and germination takes five to seven weeks (Keighery and Dixon 1980).

Seedlings grow actively during summer, responding best to a wet summer and dry winter (Keighery and Dixon 1980). They appear to be effectively established, and less prone to disease, once their stilt-like roots are formed.

Side shoots that form at the base of seedlings or adults form roots readily, and can be removed and treated as cuttings in spring and early summer. Cuttings require warm and humid conditions (Keighery and Dixon 1980).

There is evidence that suggests that adult *Pandanus spiralis* var. *flammeus* can tolerate low to moderate intensity fire. A fire in 2000 affected dense stands of *P. spiralis* var. *flammeus* removing dead leaf skirts on mature plants and blackening trunks. By July 2001 the plants had recovered.

Current status

Pandanus spiralis var. *flammeus* was declared to be rare flora (DRF) under the Western Australian *Wildlife Conservation Act 1950* in 1989 and is ranked as Endangered (EN) in WA under International Union for Conservation of Nature (IUCN 1994) criteria C2a; D. This ranking should be reviewed and updated as there are now more than 250 mature individuals known (see recovery action 16). The taxon is listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999) as Endangered. The main threats to the taxon are grazing and trampling, altered fire regimes, weeds, small population size and potentially poor genetic diversity, hydrological changes and lack of secure conservation tenure.

- **Grazing and trampling** by stock and feral animals has contributed to the loss of individuals and a contraction of the main population (documented loss is about 10% of the population and 30% of the area since 1980). The leaves of *Pandanus spiralis* var. *flammeus* seedlings are palatable to stock and seedlings/suckers need protection for several years to achieve establishment (Rowley 1993). Pigs and water buffalo also eat the leaves, fruit, seedlings and basal suckers of *Pandanus*. Small enclosure experiments showed that even a low density of exotic mammals is sufficient to maintain an open structure where *Pandanus* thickets would otherwise form (Verbeek *et al.* 1993). It is likely that such impacts will have also curtailed recruitment and regeneration (McKenzie 1981).

Panel fencing is apparently only erected around the *Pandanus spiralis* var. *flammeus* population during the latter part of the dry season. Stock grazing and trampling still appears to occur early in the dry from about March to May.

- **Altered fire regimes** may be a threat to populations of *Pandanus spiralis* var. *flammeus*. Although the taxon appears to have a moderate degree of fire tolerance, it may suffer if fires are intense. A form of fire exclusion is currently practiced in the valley, as the lessee is concerned about grass fuel build up and the risk of major fires.
- **Weeds** such as Jerusalem Thorn (*Parkinsonia aculeata*) and Mesquite (*Prosopis* sp.) are a threat to *Pandanus spiralis* var. *flammeus*.
- **Small population size and potentially poor genetic diversity** is a potential threat as there are very few plants to cross. Some plants may also be clones, having arisen asexually. Genetic diversity is needed for a species to adapt to changes in its environment. Low genetic diversity would lower this capacity.
- **Hydrological changes** may potentially impact on the taxon. A soak has been excavated at the end of the chain of pools in the valley with the likely consequences of reduction in overall moisture availability in *Pandanus* habitat.

- **Lack of secure conservation tenure** is a threat to the population as it occurs on an active pastoral lease.

The intent of this plan is to outline actions that will deal with immediate threats to *Pandanus spiralis* var. *flammeus*. Although climate change may have a long-term effect on the taxon, actions taken directly to prevent the impact of climate change are beyond the scope of this plan.

Table 2. Summary of population information and threats

Pop. No. & Location	Land Status	Year / No. of plants		Current Condition	Threats
1. Logues Spring	Pastoral Lease	1980	102 (+116 suckers)	Healthy	Grazing, trampling, fire, weeds, feral animals, hydrological changes
		2001	106 (+151 suckers)		
		2008	50 (+200 suckers)		
2. SSW of Population 1	Pastoral Lease	1984	10 (+ 10 suckers)	Healthy	Grazing, trampling, fire, weeds, feral animals, hydrological changes
		2001	4 (+8 suckers)		
		2008	Unknown		

Guide for decision-makers

Section 1 provides details of current and possible future threats. Actions for development and/or land clearing in the immediate vicinity of *Pandanus spiralis* var. *flammeus* may require assessment.

Actions that could result in any of the following may potentially result in a significant impact on *Pandanus spiralis* var. *flammeus*:

- Damage or destruction of occupied or potential habitat
- Alteration of the local surface hydrology or drainage
- Reduction in population size
- A major increase in disturbance in the vicinity of a population.

Habitat critical to the survival of *Pandanus spiralis* var. *flammeus*, and important populations

Given that *Pandanus spiralis* var. *flammeus* is ranked as EN it is considered that all known habitat for wild populations is critical to the survival of the taxon. Habitat critical to the survival of the taxon includes the habitat of populations and areas of similar habitat surrounding populations (these offer habitat for population expansion and for fauna species that interact with the plants); additional occurrences of similar habitat that may contain undiscovered populations of the taxon (e.g. Jocelyn Valley, St George Ranges) or be suitable for future translocations; and the local catchment for the surface and/or groundwater that maintains the habitat of the taxon (especially localised gullies and springs).

Benefits to other species or ecological communities

Recovery actions implemented to improve the quality or security of the habitat of *Pandanus spiralis* var. *flammeus* will also improve the status of associated native vegetation and native fauna (see Appendix 1 for full lists). In particular, enhanced exclusion of stock and feral animals, and weeds, from the gully and spring will benefit the Black-footed Rock-wallaby (*Petrogale lateralis* West Kimberley race) which is listed as vulnerable under the EPBC Act, and is poorly conserved (Department of the Environment, Water, Heritage and the Arts 2010). The valley is a premium site for this species. Numbers have been constrained by the impacts of grazing activity both above and below the cliffs where they dwell.

International obligations

This plan is fully consistent with the aims and recommendations of the Convention on Biological Diversity, ratified by Australia in June 1993, and will assist in implementing Australia's responsibilities under that convention. *Pandanus spiralis* var. *flammeus* is not listed under any specific international treaty however, and this plan does not affect Australia's obligations under any other international agreements.

Indigenous Consultation

A search of the Department of Indigenous Affairs Aboriginal Heritage Inquiry System has identified that the main *Pandanus spiralis* var. *flammeus* population is in the immediate vicinity of three culturally significant sites (ID Numbers 14397, 14398 and 14450), one of which has closed access. Input and involvement is being sought through the Kimberley Land Council, Department of Indigenous Affairs and the traditional owners of the area, the Njikená, to determine if there are any other issues or interests. The area containing the taxon does not appear to be part of contemporary Native Title negotiations. Consultation has been included as a recovery action to ensure there has been Indigenous engagement in relation to the recovery actions posed in this plan.

Social and economic impacts

Pandanus spiralis var. *flammeus* occurs on Dampier Downs which is an active pastoral lease. Population 1 is linked to a valley that retains spring moisture for much of the year and has value for stock watering. Management of stock access to the spring has economic impacts to the station lessee.

Affected interests

The stakeholders potentially affected by the implementation of this plan include the indigenous parties (especially the Kimberley Land Council), the pastoral lease holder, government agencies, and conservation organisations.

Evaluation of the Plan's Performance

DEC will evaluate the performance of this plan. In addition to annual reporting on progress and evaluation against the criteria for success and failure, the plan will be reviewed following five years of implementation.

2. RECOVERY OBJECTIVE AND CRITERIA

Objective

The objective of this plan is to abate identified threats and maintain or enhance *in situ* populations to ensure the long-term preservation of the variety in the wild.

Recovery Criteria

Criteria for success: The number of populations has increased and/or the number of mature individuals has increased by ten percent or more over the term of the plan.

Criteria for failure: The number of populations has decreased and/or the number of mature individuals has decreased by ten percent or more over the term of the plan.

3. RECOVERY ACTIONS

Existing recovery actions

The lessee has been notified of the declared rare status of the variety, its location and the associated legal obligations.

The Department of Fisheries and Wildlife undertook a biological survey of the Edgar Ranges between 1976 and 1980. Since then, there have been a number of visits. The groups involved have included DEC and the Broome Botanical Society.

Many recovery actions have been implemented and maintained by the lessee with some measures receiving financial and physical assistance from DEC and the Broome Botanical Society. These include the erection of a portable cattle barrier and the installation of a tank, pipeline, pump and trough to supply water to stock away from the *Pandanus*

Donkeys were present in large numbers until around 2000 when the Department of Agriculture and Food Western Australia removed 99% of the animals through the Judas program. Their removal would have aided recovery of the *Pandanus* and its habitat.

A population of a similar taxon in the St. George Range has been visited, but no fertile material was found to ascertain its relationship to *Pandanus spiralis* var. *flammeus*.

Seed collection has been undertaken with six plants propagated and planted in the gardens of the DEC West Kimberley District office in Broome.

Ongoing and future recovery actions

DEC is overseeing the implementation of this plan and will include information on progress in annual reports to DEC's Corporate Executive and funding bodies. Where recovery actions are implemented on lands other than those managed by DEC, permission has been or will be sought from the appropriate land managers prior to actions being undertaken. The following recovery actions are roughly in order of descending priority, influenced by their timing over the term of the plan. However this should not constrain addressing any recovery action if funding is available and other opportunities arise.

1. Establish a West Kimberley District Threatened Flora Recovery Team and coordinate recovery actions

DEC will coordinate recovery actions applicable to *Pandanus spiralis* var. *flammeus*. Once established, the West Kimberley District Threatened Flora Recovery Team (WKDTFRT) will assist DEC to coordinate recovery actions for the taxon along with other threatened species. Information on progress in implementing recovery actions will be reported through annual reports to DEC's Corporate Executive and funding bodies.

Action: Establish a WKDTFRT and coordinate recovery actions
Responsibility: DEC (West Kimberley District)
Cost: \$6,000 per year

2. Rehabilitate habitat

Rehabilitation of the valley habitat including a buffer area may help re-instate landscape functions that support *Pandanus spiralis* var. *flammeus* and associated species. This will ideally involve Department of Agriculture and Food WA (DAFWA), the lessee, Natural Resource Management (NRM) groups, indigenous stewards and other community-led groups such as Broome Botanical Society and Environs Kimberley.

Action: Rehabilitate habitat
Responsibility: DEC (West Kimberley District), DAFWA with assistance from the lessee and community organisations
Cost: \$10,000 per year

3. Ensure long-term protection of habitat

Long-term protection of the habitat of *Pandanus spiralis* var. *flammeus* may occur through the declaration of the proposed Edgar Range Nature Reserve. In the interim, consideration can be given to entering into a conservation agreement or covenant with the lessee to protect and manage the sites.

Action: Ensure long-term protection of habitat
Responsibility: DEC (West Kimberley District and Land Unit), lessee, DPI and Department of Mines and Petroleum (DOMP)
Cost: \$3,000 per year

4. Exclude stock and feral animals from the area of *Pandanus spiralis* var. *flammeus*

To eliminate the requirement for cattle to move up the gorge into the area of the *Pandanus spiralis* var. *flammeus* to obtain water, the water source established down the gorge should be maintained. The portable cattle barrier should continue to be erected during the dry season to prevent cattle and feral animals moving up the gorge.

Action: Exclude stock and feral animals from the area of *Pandanus spiralis* var. *flammeus*
Responsibility: DEC (West Kimberley District) and lessee
Cost: \$10,000 per year

5. Undertake liaison with land managers and Indigenous groups

Staff from DEC West Kimberley District will continue to liaise with the lessee and DAFWA to ensure that populations of *Pandanus spiralis* var. *flammeus* are not accidentally damaged or destroyed. Indigenous consultation will take place to determine if there are any issues or interests in areas that are habitat for *P. spiralis* var. *flammeus*.

Action: Undertake liaison with land managers and Indigenous groups
Responsibility: DEC (West Kimberley District)
Cost: \$2,000 per year

6. Investigate genetic diversity and confirm taxonomic status

Genetic studies need to be conducted to confirm the taxonomic status of the variety and to determine the number of individuals in known populations. Although *Pandanus spiralis* var. *flammeus* is dioecious, there is a high likelihood that populations contain many individuals produced by asexual reproduction and plant counts may overestimate the effective population size. Studies should also include other varieties of *Pandanus spiralis* to determine their distinctiveness and it is recommended that genetic comparisons are made between the three closest varieties of *Pandanus spiralis*; namely at Logues Spring, the Fitzroy River to the north, and Jocelyn Valley. For contrast it is suggested that the northern-most and eastern-most (Northern Territory) varieties are also included for comparison.

Action: Investigate genetic diversity and confirm taxonomic status
Responsibility: DEC (West Kimberley District and Science Division)
Cost: \$15,000 in years 1 and 2

7. Conduct weed control if necessary

Confirmation will be sought from DAFWA on the status of declared weeds in the vicinity of *Pandanus spiralis* var. *flammeus*. Eradication of *Parkinsonia* and *Prosopis* immediately north of Logues Spring may be required as both declared weeds have the potential to invade and threaten populations.

Action: Conduct weed control if necessary
Responsibility: DEC (West Kimberley District)
Cost: \$10,000 per year, as required

8. Collect seed

Preservation of genetic material is essential to guard against extinction of *Pandanus spiralis* var. *flammeus* if the wild populations are lost. It is recommended that seed be collected and stored by the DEC Threatened Flora Seed Centre (TFSC).

Action: Collect seed
Responsibility: DEC (West Kimberley District and TFSC)
Cost: \$5,000 per year

9. Undertake hydrological investigations

As maximal output of the spring may be required to optimize the area of *Pandanus spiralis* var. *flammeus* habitat in the valley outside the wet season a stock water outlet should be established outside the mouth of the valley as a reliable alternate supply. Priorities should include:

- testing for water sources on the adjacent plain and the provision of a reliable, low cost, low maintenance water source for stock.
- Monitoring the hydrology of the spring. Key questions will be: the extent of the catchment, the recharge rate, capacity and flows.

Action: Undertake hydrological investigations
Responsibility: DEC (West Kimberley District)
Cost: \$15,000 in years 2 and 3

10. Monitor populations

Monitoring will ideally include the following:

- assess the extent of stock exclusion/intrusion.
- assess the presence, extent and abundance of declared weeds.
- map *Pandanus spiralis* var. *flammeus* and undertake counts on a regular basis, with a new detailed mapped count to be made as a high priority.
- Obtain GPS coordinates of each individual.

Where possible, the involvement of the local community should be encouraged. For example the Broome Botanical Society, NRM groups and the lessee.

Action: Monitor populations
Responsibility: DEC (West Kimberley District) with assistance from community groups and the lessee
Cost: \$10,000 per year

11. Undertake surveys

The Edgar Ranges have been flown twice by fixed-wing aircraft to look for new populations of *Pandanus spiralis* var. *flammeus* and it appears that there is only a slight prospect that further populations could be located. However, it is recommended that areas of potential suitable habitat continue to be surveyed if possible. All surveyed areas will be recorded and the presence or absence of the taxon documented to increase survey efficiency and reduce unnecessary duplicate surveys. If possible, volunteers from the local community and the lessee will be encouraged to become involved.

Action: Undertake surveys
Responsibility: DEC (West Kimberley District) with assistance from community groups and the lessee
Cost: \$10,000 in years 2, 3 and 4

12. Develop and implement a fire management strategy

Fire will be moderated in the habitat of the populations and used carefully as a recovery tool in the catchment in the adjacent range. A buffer against wildfire will need to be established near the *Pandanus spiralis* var. *flammeus*, especially at the mouth of the valley. A fire management strategy will be developed in consultation with relevant authorities and land managers that recommends appropriate fire frequency, intensity, season, and control measures. The proposed fire regime will ultimately be integrated with a fire management plan for the proposed Edgar Range Nature Reserve.

Action: Develop and implement a fire management strategy
Responsibility: DEC (West Kimberley District) and relevant authorities
Cost: \$10,000 in first year and \$2,000 in subsequent years

13. Start the translocation process if necessary

Translocation may be deemed desirable for the conservation of *Pandanus spiralis* var. *flammeus* if surveys fail to locate new populations. If necessary, a translocation proposal will be developed and suitable translocation sites selected. Information on the translocation of threatened plants and animals in the wild is provided in the Department's Policy Statement No. 29 *Translocation of Threatened Flora and Fauna*. Translocation should meet the standards set in Guidelines for the Translocation of Threatened Australian Plants (Vallee *et al* 2004). All translocation proposals require endorsement by DEC's Director of Nature Conservation. Monitoring of translocations is essential and will be included in the timetable developed for the Translocation Proposal.

Action: Start the translocation process if necessary
Responsibility: DEC (Science Division and West Kimberley District)
Cost: \$20,000 in years 3, 4 and 5

14. Obtain biological and ecological information

A knowledge of the biology and ecology of *Pandanus spiralis* var. *flammeus* will provide a scientific basis for its management in the wild. Investigations will ideally include:

- Study of the soil seed bank dynamics and the role of various factors including disturbance, competition, drought, inundation and grazing in recruitment and seedling survival.
- Determination of reproductive strategies, phenology and seasonal growth.
- Investigation of reproductive success and pollination biology.
- Investigation of minimum viable population size.
- The impact of changes in hydrology in the habitat.

Action: Obtain biological and ecological information
Responsibility: DEC (Science Division and West Kimberley District)
Cost: \$10,000 per year

15. Map habitat critical to the survival of *Pandanus spiralis* var. *flammeus*

It is a requirement of the EPBC Act that spatial data relating to habitat critical to the survival of *Pandanus spiralis* var. *flammeus* be determined. This is alluded to in Section 1 and, at the broad scale, this action has essentially been completed but will need to be refined. If additional populations are located, then habitat critical to their survival will also be determined and mapped.

Action: Map habitat critical to the survival of *Pandanus spiralis* var. *flammeus*
Responsibility: DEC (West Kimberley District)
Cost: \$6,000 in year 2

16. Review and update the ranking of *Pandanus spiralis* var. *flammeus*

It is recommended that the ranking of *Pandanus spiralis* var. *flammeus* be reviewed and updated as the taxon no longer meets the current IUCN criteria.

Action: Review and update the ranking of *Pandanus spiralis* var. *flammeus*
Responsibility: DEC (SCB, West Kimberley District)
Cost: \$2,000 in year 1

17. Review this plan and assess the need for further recovery actions

If *Pandanus spiralis* var. *flammeus* is still ranked as Endangered at the end of the five-year term of this plan, the need for further recovery actions, or a review of this plan will be assessed and a revised plan prepared if necessary.

Action: Review this plan and assess the need for further recovery actions
Responsibility: DEC (SCB and West Kimberley District)

Cost: \$3,000 in year 5

Table 3. Summary of Recovery Actions

Recovery Action	Priority	Responsibility	Completion Date
Establish a West Kimberley District Threatened Flora Recovery Team and coordinate recovery actions	High	DEC (West Kimberley District)	Ongoing
Rehabilitate habitat	High	DEC (West Kimberley District), DAFWA with assistance from the lessee and community organisations	2016
Ensure long-term protection of habitat	High	DEC (West Kimberley District and Land Unit), lessee, DPI and Department of Mines and Petroleum (DOMP)	Ongoing
Exclude stock and feral animals from the area of <i>spiralis</i> var. <i>flammeus</i>	High	DEC (West Kimberley District) and lessee	Ongoing
Undertake liaison with land managers and indigenous communities	High	DEC (West Kimberley District)	Ongoing
Investigate genetic diversity and confirm taxonomic status	High	DEC (West Kimberley District and Science Division)	2013
Conduct weed control if necessary	High	DEC (West Kimberley District)	Ongoing
Collect seed	High	DEC (West Kimberley District and TFSC)	Ongoing
Undertake hydrological investigations	High	DEC (West Kimberley District)	2014
Monitor populations	High	DEC (West Kimberley District) with assistance from community groups and the lessee	Ongoing
Undertake surveys	High	DEC (West Kimberley District) with assistance from community groups and the lessee	Ongoing
Develop and implement a fire management strategy	High	DEC (West Kimberley District) and relevant authorities	Developed by 2012 with implementation ongoing
Start the translocation process, if necessary	Medium	DEC (Science Division and West Kimberley District)	2013, ongoing
Obtain biological and ecological information	Medium	DEC (Science Division and West Kimberley District)	Ongoing
Map habitat critical to the survival of <i>Pandanus spiralis</i> var. <i>flammeus</i>	Medium	DEC (West Kimberley District)	2013
Review and update the ranking of <i>Pandanus spiralis</i> var. <i>flammeus</i>	Medium	DEC (SCB and West Kimberley District)	2012
Review this plan and assess the need for further recovery actions	Medium	DEC (SCB and West Kimberley District)	2016

4. TERM OF PLAN

This plan will operate from September 2011 to August 2016 but will remain in force until withdrawn or replaced. If *Pandanus spiralis* var. *flammeus* is still ranked EN after five years, the need for further recovery actions will be determined.

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6. TAXONOMIC DESCRIPTION

Pandanus spiralis var. *flammeus* is a narrow trunked plant to 5 m high with bluish-green, sword-like leaves that are 4-5cm wide when mature. Leaves are held in a close spiralled arrangement around the stems, which also produce aerial roots (Brown *et al.* 1998).

The pendulous cephalium (fruiting heads) comprise many individual drupes. This variety is distinguished by the scarlet colouration to the fruiting heads, which are 13 cm long and wide. These heads have 16 blocks (groups of drupes) and are smaller than those of the typical variety *Pandanus spiralis* var. *spiralis* which are spherical and have up to 24 blocks (Brown *et al.* 1998; Keighery and Dixon 1980; Stone 1978). See Stone (1978) for fruit images.