

Threatened Tasmanian Grasstrees

Xanthorrhoea arenaria and *Xanthorrhoea bracteata*



Flora Recovery Plan 2006 - 2010



DISCLAIMER

This recovery plan recognises that identification of *Xanthorrhoea* to species level can be difficult as plants often exhibit intermediate or combined characters of the listed species, *Xanthorrhoea bracteata* and *Xanthorrhoea arenaria* and the non-listed *Xanthorrhoea australis*. The identification difficulty arises from the large degree of variation inherent within each of these species and considerable overlap of the variation between species as well as reports of hybridisation and introgression between species. The identity of populations which have closer affinities to either *Xanthorrhoea arenaria* or *Xanthorrhoea bracteata* have therefore often been recorded by observers as *Xanthorrhoea* aff. *arenaria* or *Xanthorrhoea* aff. *bracteata* respectively, though this rarely, if ever, precludes the existence of individual plants within those populations that could be ascribed to either *Xanthorrhoea arenaria* or *Xanthorrhoea bracteata*. In a few cases, observers could not be contacted to confirm the occurrence of either *Xanthorrhoea arenaria* or *Xanthorrhoea bracteata* at such sites and they are included in the population table in this plan as they were recorded (*Xanthorrhoea* aff. *bracteata*). Until the occurrence of *Xanthorrhoea arenaria* or *Xanthorrhoea bracteata* can be verified at these sites, it is recommended that such populations be considered as threatened and treated accordingly.

ACKNOWLEDGEMENTS

This plan was prepared by Eve Lazarus (TSS) with advice from Wendy Potts (TSS), Tim Rudman (Vegetation Section, BCB), Alex Buchanan and Dennis Morris (Tasmanian Herbarium), Richard Barnes (Private Forest Reserves Program, DPIW), Richard Schahinger, Mark Wapstra (Forest Practices Authority) and Tim Wardlaw (Forestry Tasmania), Alison Woolley (Forestry Tasmania/ Conservation Assessment Section, DPIW) and Steve Casey (Conservation Assessment Section, DPIW). This plan was updated and edited by Justine Shaw (TSS). The Threatened Tasmanian Grasstrees Recovery Plan draws on information on *Xanthorrhoea bracteata* included in the Recovery Plan for Selected Tasmanian Forest Associated Plants by Barker and Johnson (1998) and the expert opinion of those listed above. This Plan was prepared with support from the Commonwealth Department of Environment and Heritage. Edited by Wendy Potts. Map produced by Kristy Goddard. (TSS). Cover produced by Gina Donnelly (Graphic Services, ILS, DPIW).

Cover photo of *Xanthorrhoea arenaria* by Greg Jordan.

Citation: Threatened Species Section (2006). *Flora Recovery Plan: Threatened Tasmanian Grasstrees 2006-2010*. Department of Primary Industries and Water, Hobart.

© Threatened Species Section, DPIW

This work is **copyright**. It may be reproduced for study, research or training purposes subject to an acknowledgment of the sources and no commercial usage or sale. Requests and enquires concerning reproduction and rights should be addressed to the Manager, Threatened Species Section.

ISBN: 0 7246 6349 5

Abbreviations

BCB	Biodiversity Conservation Branch, DPIW
DPIW	Department of Primary Industries and Water, Tasmania (formerly DPIWE)
DPIWE	Department of Primary Industries, Water and Environment, Tasmania
DTAE	Department of Tourism, Arts and the Environment
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
IBRA	Interim Bio-Regionalisation for Australia
IUCN	International Union for the Conservation of Nature
NRM region	Natural Resource Management Region
PAMA	Public Authority Management Agreement
TSP Act	<i>Threatened Species Protection Act 1995</i>
TSS	Threatened Species Section, Biodiversity Conservation Branch, DPIW

Taxonomy follows Buchanan (2005) except where otherwise noted.

The listing status of the threatened species referred to in this recovery plan was correct at the time of publication.

CONTENTS

SUMMARY	4
BACKGROUND INFORMATION	7
Description	7
Taxonomic Status	8
Habitat and Distribution.....	9
Population Estimate	9
Distribution Map	10
Table 2 Key Populations of <i>Xanthorrhoea</i> species.....	11
Life History and Ecology.....	15
Threats, Limiting Factors and Management Issues.....	15
Reservation Status.....	17
Conservation Status and Habitat Critical to the Survival of Species.....	18
Existing Conservation Measures	19
RECOVERY PLAN.....	20
Recovery Objectives, Performance Criteria and Actions Needed.....	20
Strategy for Recovery and Progress Evaluation.....	22
Affected Interests and Social and Economic Impacts.....	22
Biodiversity Benefits.....	22
Recovery Actions.....	23
1. Determine extent, abundance, threats and priority sites for conservation.....	23
2. Prevent significant decline in known populations.....	23
3. Protection against changes in land-use.....	24
4. Survey for new populations	25
5. Determine appropriate disturbance needs for recruitment in populations and advise and help landowners/managers to manage habitat in order to maintain or increase population size.....	26
6. Reassess <i>Xanthorrhoea</i> taxonomy to develop a useable field identification system and protocols for dealing with hybridisation and species continuums.....	27
7. Reassess the conservation status of all Tasmanian grasstrees	27
8. Long term management.....	28
BIBLIOGRAPHY	29
Appendix 1. Distribution of <i>Xanthorrhoea</i> species in Tasmania (DPIW 2006).....	31

SUMMARY

Current Species Status

Xanthorrhoea arenaria

Australian *Environment Protection and Biodiversity Conservation Act 1999*
Tasmanian *Threatened Species Protection Act 1995*

Vulnerable
vulnerable

Xanthorrhoea bracteata

Australian *Environment Protection and Biodiversity Conservation Act 1999*
Tasmanian *Threatened Species Protection Act 1995*

Endangered
vulnerable

Xanthorrhoea arenaria Bedford (1986), commonly known as the sand grasstree, is endemic to Tasmania and is known from approximately 13 sites between Bridport and Coles Bay in the northeast of the State. A continuing decline is inferred due to infection by *Phytophthora cinnamomi*, the risk from land clearance, inappropriate burning and other disturbance regimes and over-harvesting of foliage. Data deficiency due to uncertain taxonomic status is also an issue with this species.

Xanthorrhoea bracteata Brown (1810), commonly known as the shiny grasstree, is endemic to Tasmania and is known from approximately 18 sites between Narawntapu National Park and Mount William in the northeast of the State. A continuing decline is inferred due to the reasons listed above for *Xanthorrhoea arenaria*.

Habitat Requirements and Limiting Factors

Flowering in *Xanthorrhoea* species is unpredictable, but mostly stimulated by fire. The habitat requirements of the Tasmanian threatened *Xanthorrhoea* species are not well understood. The major threat faced is infection by the root rot pathogen *Phytophthora cinnamomi*, which is prevalent in much of the habitat containing *Xanthorrhoea arenaria* and *Xanthorrhoea bracteata*. Plants are also at risk from land clearance due to housing, agriculture and mining, and a decline in the quality of habitat through inappropriate fire and disturbance regimes. The morphology of the Tasmanian *Xanthorrhoea* species is confusing as some plants exhibit intermediate or combined characters of *Xanthorrhoea australis*, *Xanthorrhoea bracteata* and *Xanthorrhoea arenaria*. As a result, identification to species level may be difficult until these taxonomic issues are resolved. Due to this confusion, population information is limited and previous conservation status assessments have been conducted using rudimentary data.

Overall Recovery Objective

The **overall objective** of the Recovery Plan is to determine the status of *Xanthorrhoea arenaria* and *Xanthorrhoea bracteata* and to minimise further decline of the species. This will require the management of existing populations, further survey, the protection of *Phytophthora cinnamomi* free populations through conservation covenants and land management agreements and taxonomic review.

Specific Objectives

1. Prevent or minimise decline in known populations particularly with respect to management of *Phytophthora cinnamomi*.
2. Determine the extent of threatened grasstrees in Tasmania.
3. Develop a field-based identification system to enable appropriate management of threatened Tasmanian grasstrees.
4. Manage populations in the long term.

Performance Criteria

1. No significant decline in area occupied within each of the known populations due to land clearance.
2. The distribution and abundance of threatened grasstrees at all known sites have been mapped and threatening processes identified.
3. At least 2 priority *Phytophthora cinnamomi* free sites (preferably containing both species) have been identified and are being managed.
4. Improved security through management agreements (preferably with covenants signed) has occurred following discussions held with landowner/managers to secure populations in perpetuity.
5. Appropriate *Phytophthora cinnamomi* management has been implemented on all priority sites and standard management prescriptions have been developed specifically for the threatened Tasmanian grasstrees.
6. Data relating to *Xanthorrhoea* characteristics and distribution has been compiled and is easily accessible.
7. Monitoring of populations has been conducted to determine the response of the species to *Phytophthora cinnamomi* and the disturbance requirements to maintain abundance or improve habitat condition.
8. Establishment of a Recovery Team when funding is procured to implement this plan or parts thereof.
9. Update listing statements and spatial and population data as required and circulate this information to the wider botanical community and general public in the appropriate form i.e. update TSS databases, circulate updated information to the Tasmanian Flora Network and update the DPIW threatened species website as necessary, provide data to relevant State and Federal agencies, and include threatened species sites on LIST (Land Information Systems Tasmania) to alert potential landowners as to possible restrictions by the end of year 1.
10. Specimens of each population lodged with the Tasmanian Herbarium by the end of year 1.
11. Annual requests made to volunteer networks (e.g. Wildcare, Threatened Species Network) to encourage active involvement in the Recovery process.
12. Maintenance of the TSS database (ie. new populations, population decline and threshold conditions) and annual assessment to determine whether management intervention is required.
13. Reassessment of the conservation status when information is available, storage of revised assessments in the TSS conservation status assessment database, and preparation of nominations for a change in status for State and Federal legislation if a change in status is considered necessary.
14. Update the Recovery Plan by the end of 2010.

Actions Needed

1. Determine extent, abundance, threats and priority sites for conservation.
2. To manage the sites to prevent significant decline.
3. Protection against changes in land-use.
4. Survey for new populations.
5. Determine appropriate disturbance needs for recruitment and assist landowners/managers to manage habitat in order to maintain or increase population size.
6. Reassess *Xanthorrhoea* taxonomy and develop a useable field identification system and protocols for dealing with hybridisation and species continuums.
7. Re-assess the conservation status of all Tasmanian *Xanthorrhoea*.
8. Implement long term management.

Estimated Cost of Recovery

Actions	Cost estimate	Timeframe	NRM region
1. Assessment of known sites	\$50,000	Year 1-5	State
2. Prevent decline in known populations	\$80,000	Year 1-5	State
3. Protection from change in land-use	\$100,000	Year 1-5	State
4. Survey for new populations	\$20,000	Year 1-5	State
5. Disturbance needs	\$20,000	Year 1-5	State
6. Taxonomic reassessment	\$60,000	Year 1-5	State
7. Reassessment of Conservation Status	\$15,000	Year 1-5	State
8. Long term management	\$22,000	Year 1-5	State
Total	\$367,000		

BACKGROUND INFORMATION

This section draws from Curtis & Morris (1994), Pole (1994) and the Tasmanian Public Land Use Commission (1997).

Description

The Tasmanian threatened grasstrees include *Xanthorrhoea arenaria* and *Xanthorrhoea bracteata*, both of which do not have a trunk, rather the stem and root (caudex) is branched below the ground. Tufts termed crowns arise directly from the ground. One other *Xanthorrhoea* species occurs in Tasmania, *Xanthorrhoea australis*. This species has a trunk and usually has only one crown.

Xanthorrhoea arenaria has slightly greyish or bluish-green leaves that measure between 40-80 cm long, 2-3 mm wide and 1-2.5 mm thick. The scape (naked stem below flower spike) is between 20 and 60 cm long and 8-11 mm in diameter. The flowers are arranged in a spike that is greater than one-third but less than half the length of the flower stem. The flowering time for this species is between June and January. The fruit is a capsule and the seeds are round or oval and slightly flattened.

Xanthorrhoea bracteata has leaves between 40 and 110 cm long, and 1.5-3 mm wide. The flower head is usually less than a third the length of the scape (bare stem below the flower head). The scape is very thin (4 to 9 mm in diameter). The flowers are small and white (about 3 mm wide) and are organised in tight clusters that are surrounded by brown bracts and floral leaves (leaves that look like petals). Flowering occurs from January to February. The fruit is a capsule and the seeds are round or oval and slightly flattened.

All *Xanthorrhoea* species have an underground rootstock from which they regenerate after disturbance.

The identification of the Tasmanian *Xanthorrhoea* is difficult because of the large degree of variation inherent within the species and considerable overlap of the characteristics between species. In addition, there have been reports of hybridisation between *Xanthorrhoea bracteata* and *Xanthorrhoea australis* and also *Xanthorrhoea arenaria* and *Xanthorrhoea australis* (Flora of Australia 1986; North Barker Ecosystem Services 2004). Hybridisation and introgression could add to the variation within the three currently accepted Tasmanian taxa. As a result, some plants exhibit intermediate or combined characters of *Xanthorrhoea bracteata*, *Xanthorrhoea arenaria* and *Xanthorrhoea australis*. Two or more of these taxa may co-occur at a site, particularly if there is a gradation in environmental factors such as slope or drainage. Lack of diagnostic characters due to immature developmental stage or slashing of mature plants may further confound identification. Table 1 summarises the characteristics of the known Tasmanian *Xanthorrhoea* species.

Populations with closer affinities to either *Xanthorrhoea arenaria* or *Xanthorrhoea bracteata* have often been recorded as *Xanthorrhoea* aff. *arenaria* or *Xanthorrhoea* aff. *bracteata* respectively, though this rarely, if ever, precludes the existence of individual plants within those populations that could be ascribed to either *Xanthorrhoea arenaria* or *Xanthorrhoea bracteata*. In a few cases, observers could not be contacted to confirm the occurrence of either *Xanthorrhoea arenaria* or *Xanthorrhoea bracteata* at such sites and they are included in the population table in this plan as they were recorded (*Xanthorrhoea* aff. *bracteata*). Until the occurrence of *Xanthorrhoea arenaria* or *Xanthorrhoea bracteata* can be verified at these sites, it is recommended that such populations be considered as threatened and treated accordingly. Protocols need to be developed on how to treat plants that exhibit intermediate or combined characters to those of the currently listed *Xanthorrhoea* taxa. Other 'unusual' *Xanthorrhoea* populations have also been located from Sisters Beach and Arthur River and investigation to determine their taxonomic status is required.

Table 1: Morphological Characteristics of Tasmanian *Xanthorrhoea* species

	<i>Xanthorrhoea bracteata</i>	<i>Xanthorrhoea arenaria</i>	<i>Xanthorrhoea australis</i>
Trunk	no	no	trunk to 3 m tall
Crown	Multiple	Multiple	Single (predominantly)
Flower spike	Usually less than 1/3 of scape length	> 1/3 but < 1/2 of scape length	2 to 6 times as long as the scape length
Leaves	40 – 110 cm long	40-80 cm long	>100 cm long
Scape	Very thin (4 to 9 mm diameter)	Thin to thick (8 to 11 mm diameter)	Thick (18 to 40 mm diameter)
Packing bracts	Triangular to narrowly triangular and hairless	Tapering to a point – awl-shaped and hairless	Elongated, tapering to a point – awl-shaped and hairless
Sepals	Triangular, beaked without proboscis and hairless	Triangular to narrowly triangular with very long beak, hairless and with proboscis	Triangular to narrowly triangular with very long beak, hairless and with proboscis
Petals	Bent or curved backward, often without proboscis, hairless except for those at the tips	Erect to slightly recurved with proboscis, hairless except for those at the tips and on proboscis	Erect to slightly recurved with proboscis, hairless except for those at the tips
Habitat	Sandy soils often acid and waterlogged, coastal areas	Sandy heaths	Sandy soils
Tasmanian distribution	Between Asbestos Range and Waterhouse Point in the northeast	Bridport to Coles Bay (northeast to east coast)	Widespread
Flowering time	January to February	June to January	July to December

Terminology

Packing bracts – mass of small bracts that cover the stem of the inflorescence (fill space between flowers and give spike-like appearance).

Cluster bracts – underlie the clusters of flowers.

Beak – a continuation of the sepal or petal at the tips, which contains a tuft of hairs.

Proboscis – a small projection that is on the upper surface of the beak that is always hairy.

Taxonomic Status

Xanthorrhoea is a genus in the Xanthorrhoeaceae, a family represented by 11 genera in Australia. There are 28 *Xanthorrhoea* species in Australia. Tasmania is home to 3 of these, including *Xanthorrhoea arenaria* and *Xanthorrhoea bracteata*, which are endemic to the State. *Xanthorrhoea minor* was included in the Tasmanian census, however, this epithet referred to *Xanthorrhoea bracteata* before Bedford had reassessed the *Xanthorrhoea* genus in 1986 for the *Flora of Australia*. Of the three Tasmanian species, *Xanthorrhoea arenaria* and *Xanthorrhoea bracteata* are listed on the TSP and EPBC Acts.

Identification of Tasmanian grasstrees to species level is not always possible as they often exhibit intermediate or combined characters, possibly due to hybridisation and introgression (refer to the Description section above).

This requires clarification. The taxonomic identity of unusual grasstrees at Sisters Beach and Arthur River also requires clarification.

Habitat and Distribution

Xanthorrhoea arenaria is endemic to Tasmania and found predominantly in coastal sandy heath from Bridport in the northeast to Coles Bay on the East Coast. *Xanthorrhoea bracteata* is also endemic to Tasmania and occurs between Narawntapu National Park in the north and Waterhouse Point in the northeast. The habitat of *Xanthorrhoea bracteata* consists of coastal heathland and coastal *Eucalyptus amygdalina*/*Allocasuarina littoralis* forest. The two species can be found in close proximity in the northeast, namely Bridport, Waterhouse and Mt William. The substrate on which these species occur is predominantly coastal sand and gravel or non-marine sediments (gravel, sand, silt, clay and regolith).

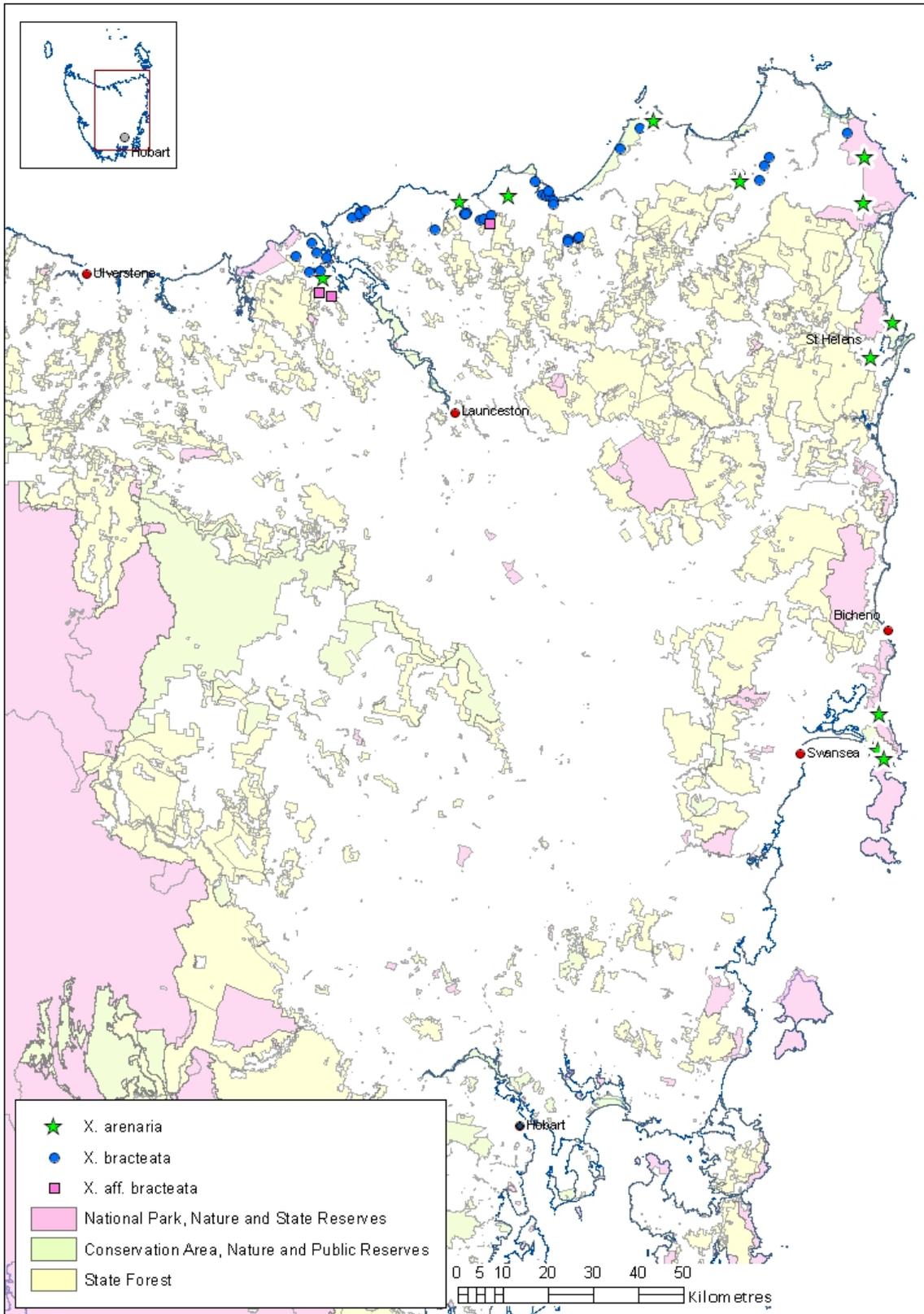
Map 1 shows the species distribution. Sites of *Xanthorrhoea* generally occur in the Northern NRM (Natural Resource Management) region with some *Xanthorrhoea arenaria* populations near Coles Bay falling in the Southern NRM region (see population table). The IBRA 5 regions that contain threatened *Xanthorrhoea* species include Northern Slopes, Flinders, Ben Lomond and South East (Environment Australia 2000).

Appendix 1 shows the distribution of all *Xanthorrhoea* species in Tasmania.

Population Estimate

Numbers of threatened *Xanthorrhoea* plants are estimated in the thousands. However, due to their unclear taxonomic status and the confusion of field identification, precise individual and population estimates are not available. Significant sites of *Xanthorrhoea bracteata* include land near Pipers Brook and between Tomahawk and Campbells Point (plants dispersed along the roadside to Tomahawk and across the coastal strip to Campbells Point), the Waterhouse Conservation Area and the Stony Head Artillery Range. The most significant sites for *Xanthorrhoea arenaria* are from the vicinity of Coles Bay. There are approximately 35 populations throughout the north and northeast requiring taxonomic verification and population estimates. It is likely that more populations of the listed species exist, particularly as large amounts of coastal habitat are privately owned and may not have been thoroughly searched. Populations and their locations are listed in the Table 2.

Distribution



Map 1. Distribution of threatened *Xanthorrhoea* species records (DPIW, GT SPOT 2005)

Table 2. Key Populations of *Xanthorrhoea* species

	Location and Tenure	NRM region	1:25 000 mapsheet	Year last seen	Species #	No of Individ.	East (AGD66)	North (AGD66)
1.	2 km south east of Greens Beach – unknown number of sites Private land	N	Greens Beach, Low Head	1986	<i>bracteata</i>	-	480000	5450200
2.	5km from Badger Beach, Badger Head Road – unknown number of sites Private land	N	Port Sorell	1979	<i>bracteata</i>	-	476400	5447300
3.	1.5 km south west of Kelso – unknown number of sites Private land	N	Bell Bay	1993	<i>bracteata</i>	-	481100	5448150
4.	Clarence Point Road – Port Dalrymple Private land	N	Bell Bay	1975	<i>bracteata</i>	-	483200	5447000
5.	South of Five Mile Bluff - 5 sites Private land	N	Low Head	2001 2000 2000 2002 2000	<i>bracteata</i>	-	490500 488872 490910 490700 491850	5456300 5455924 5457383 5456785 5457500
6.	Piper's River (3.5 km northeast) – unknown number of sites Private land	N	Weymouth	2002	<i>bracteata</i>	-	507425	5453325
7.	Sandy Points Road south of Lades Beach – unknown number of sites Private land	N	Bridport	1997	<i>bracteata</i>	-	529500	5464000
8.	Sandy Points Road Bridport – 3 sites Private land	N	Bridport	1981 1981 1948	<i>bracteata</i>	-	531200 532000 532900	5461000 5460800 5460900
9.	Bridport south – unknown number of sites Private land	N	Bowood	1953 1988	<i>bracteata</i>	-	533700 533600	5459700 5458800
10.	Muddy Creek (off Bridport Road) – unknown number of sites Private land	N	Bowood	2000 2000	<i>bracteata</i>	-	537000 537036	5451050 5450525

	Location and Tenure	NRM region	1:25 000 mapsheet	Year last seen	Species #	No of Individ.	East (AGD66)	North (AGD66)
11.	Badger Hill (off Bridport Road) – unknown number of sites State forest	N	Bowood	1996 1996	<i>bracteata</i>	990	539200 539400	5451300 5451500
12.	Northeast of Blackman's Lagoon – unknown number of sites Waterhouse Conservation Area	N	Waterhouse	1961	<i>bracteata</i>	-	548500	5471500
13.	Hardwicks Hill – unknown number of sites Waterhouse Conservation Area	N	Waterhouse	1993	<i>bracteata</i>	-	552800	5475900
14.	One Tree Hill (Waterhouse) – unknown number of sites Waterhouse Conservation area	N	Waterhouse	1983	<i>arenaria</i>	-	556300	5477600
15.	Little Boobyalla River Conservation Area – unknown number of sites Little Boobyalla River Conservation Area	N	Monarch Monarch	1996 1989	<i>bracteata</i> & <i>arenaria</i>	60	575250 575300	5465750 5464200
16.	Scrubby Creek (NE of Wedgetail Peak) – unknown number of sites Cameron Regional Reserve	N	Monarch	1983	<i>bracteata</i>	-	579400	5464400
17.	Gincase Creek (abandoned mines) – unknown number of sites Cameron Regional Reserve	N	Gladstone		<i>bracteata</i>	-	580500	5467500
18.	Great Northern Plain – unknown number of sites Cameron Regional Reserve	N	Gladstone	2000	<i>bracteata</i>	-	581700	5469500
19.	Musselroe Road – unknown number of sites Mount William National Park	N	Musselroe	1996	<i>bracteata</i>	-	598900	5475000
20.	South of Beauty Point – unknown number of sites Public reserve (CLA reserve)	N	Bell Bay	1978	<i>arenaria</i>	-	482807	5442444
21.	Weymouth – unknown number of sites Private land	N	Weymouth	1942	<i>arenaria</i>	-	513000	5459500
22.	Bridport – unknown number of sites Bridport Coastal Reserve	N	Bridport	N/A 1948	<i>bracteata</i> & <i>arenaria</i>	-	532700 523900	5462000 5460900

	Location and Tenure	NRM region	1:25 000 mapsheet	Year last seen	Species #	No of Individ.	East (AGD66)	North (AGD66)
23.	Cray Creek (Mount William) – unknown number of sites Mount William National Park	N	Eddystone	1983	<i>arenaria</i>	-	603000	5469500
24.	Icena Creek (Mount William) – unknown number of sites Private land	N	Ansons Bay	2002	<i>arenaria</i>	-	602650	5459300
25.	Binalong Bay – unknown number of sites Humbug Point Nature Recreation Area	N	Binalong	1945	<i>arenaria</i>	-	609400	5432400
26.	St Helens – unknown number of sites Private land	N	St Helens	1945	<i>arenaria</i>	-	604500	5424500
27.	Saltwater Lagoon – unknown number of sites Freycinet National Park	S	Friendly	1994	<i>arenaria</i>	-	606163	5344463
28.	Coles Bay (Saltwater Creek) – unknown number of sites Freycinet National Park, Coles Bay Conservation Area and Public reserve	S	Coles Bay	2004	<i>arenaria</i>	2300+	605100 605100 606090 607500	5337100 5337100 5336457 5334500
29.	York Town region – unknown number of sites Private Land	N	Port Sorell	2001	<i>bracteata</i>	-	479545	5443760
30.	Beauty Point (Ilfraville) – unknown number of sites Private Land	N	Bell Bay	2001	<i>bracteata</i>	-	481856	5443955
31.	Beaconsfield Reservoir area – unknown number of sites Crown Land	N	Beaconsfield	2001	aff. <i>bracteata</i>	-	481745	5439082
32.	Cabbage Tree area – unknown number of sites Crown Land	N	Beaconsfield	2001	aff. <i>bracteata</i>	-	484362	5438218
33.	Bellingham (Pipers Brook) – three sites Private land (negotiations under way for purchase)	N	Weymouth	2003	<i>bracteata</i>	10 25 100s	513963 514361 514250	5456849 5457038 5456750

	Location and Tenure	NRM region	1:25 000 mapsheet	Year last seen	Species #	No of Individ.	East (AGD66)	North (AGD66)
34.	Bridport Road – along roadside Private land	N	Weymouth		<i>bracteata</i>	-	517417 518336 519800	5455512 5455567 5456428
35.	Little Piper River area – unknown number of sites State forest	N	Weymouth	1995	aff. <i>bracteata</i>	-	519500	5454500

* **Note:** *X. aff. bracteata* records in the table are based on the field identification of the recorder.

* **Note:** All sites are threatened from infection by *Phytophthora cinnamomi* and inappropriate fire regimes. Further survey and monitoring is required to ascertain threats to each population.

Life History and Ecology

This section is compiled from Curtis & Morris (1994), Flora of Australia (1986), Lamont & Downes (1979), Phillips & Watson (1991), Staff (1974), Tasmanian Public Land Use Commission (1997) and Whelan (1995).

The threatened Tasmanian *Xanthorrhoea* species are perennial shrubs that have greatly enhanced flowering after fire. It is not known if flowering is in response to competition, light, temperature or nutrient levels as these factors are all likely to vary in the event of fire. One theory is that smoke may promote flowering due to the presence of ethylene, which is a naturally occurring plant growth regulator that has been associated with flowering. Others suggest that increased flowering tends to be related to soil warming and chemical change as well as the removal of foliage, which motivates the plant to produce seed. Insect attack and other disturbance can cause individuals to flower. However, in the absence of these factors, the production of a flower spike appears to occur on a random basis. In some instances, horticulturalists apply a blowtorch to the plant to stimulate the production of a flower spike.

The flowers of *Xanthorrhoea* species are thought to be insect pollinated, however, literature indicates that several species of fauna visit the flower spikes due to the presence of nectar. These include a range of birds such as honeyeaters and wattle birds, as well as small mammals. Insect pollinators are thought to include ants, wasps, bees and beetles. It is recognised that not all visitors are associated with pollination, particularly as the leaf bases exude a strong smelling resin that is attractive to insects. The flower spike grows extremely fast; in *Xanthorrhoea australis* a height of 49 cm was recorded over 7 days. This fast growth is attributed to the fact that the scape becomes green and photosynthetic as it grows beyond the leaves. Due to its large size, compared to the foliage, the scape can significantly contribute to its own growth.

Recruitment of *Xanthorrhoea* species is from seed, particularly following fire or soil disturbance. Seed germination follows approximately 6 to 12 months after fire. *Xanthorrhoea* species are notoriously slow growing, often taking hundreds of years to develop a trunk. Longevity of the threatened Tasmanian grasstrees requires investigation. The structure of grasstree populations indicates that recruitment is linked to episodic events. The seed appears to have short viability. Large amounts of seed are generally produced (2 seeds contained in each capsule on the flower spike) and germination is relatively easy, though in the wild, the right set of conditions need to be present. Research is required to determine what intensity of fire is most beneficial for flower production.

Young seedlings are drawn into the ground by contractile roots, apparently to protect the vulnerable apex. The seedlings are extremely slow growing and take 2-3 years to reach a stage suitable for planting. Mature plants can live for up to 300 years. Established plants of *Xanthorrhoea arenaria* and *Xanthorrhoea bracteata* are able to resprout after severe injury. Experiments with *Xanthorrhoea australis* indicate that even decapitation of the plant is followed by axillary and adventitious root and shoot development. However, it is noted that not all *Xanthorrhoea* species would survive such damage. Foliage production increases dramatically after fire.

Threats, Limiting Factors and Management Issues

Xanthorrhoea arenaria and *Xanthorrhoea bracteata* are at risk of infection by *Phytophthora cinnamomi*, conversion of habitat, inappropriate fire regimes, over-harvesting of foliage and data deficiency due to their uncertain taxonomic status.

Phytophthora cinnamomi is listed as a key threatened process under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The threatened Tasmanian grasstrees are at high risk due to their susceptibility to *Phytophthora cinnamomi*, commonly known as root rot. The pathogen is spread by running water and mud transported on footwear, vehicles and animal fur. There are several factors that increase the chance of disease infection and spread, such as low lying topography, close proximity to vehicular tracks and gravel roads, inappropriate road maintenance practices, infected gravel sources and bushwalkers (Barker 1994, Barker & Wardlaw 1995). *Xanthorrhoea arenaria* and *Xanthorrhoea bracteata* are most abundant in coastal heathland sites, many of which suffer from infection by *Phytophthora cinnamomi*. Plants contained within forest communities may be less susceptible, particularly if they occur on drier sites that are topographically higher and naturally protected against floods. A line of research under investigation in Australia at present is the

application of phosphonate, a chemical treatment that increases resistance to *Phytophthora cinnamomi* attack in treated plants. The efficacy of phosphonate in Tasmania is not well understood due to a lack of data and scientific study.

Due to the nature of *Phytophthora cinnamomi*, the capacity for long term *Xanthorrhoea* conservation sites on Crown land is limited. There are few public reserves that do not have *Phytophthora cinnamomi* in the vicinity and most have little in the way of buffers surrounding populations. The northeast traditionally has high recreational off-road vehicle use, which is problematic when trying to contain *Phytophthora cinnamomi*. The potential threats are compounded by illegal woodcutting, which targets *Eucalyptus amygdalina* forest communities. Increased support for management of threats is needed.

For a cooperative approach to management of important *Xanthorrhoea* sites on Crown land, Public Authority Management Agreements may be sought. These agreements are legally binding and involve the cooperation of two or more public authorities, such as Forestry Tasmania and DPIW. Prescriptions agreed upon by both agencies can be consolidated and management responsibility then rests with the controlling authority.

In order to secure long term management sites, agreements on private land are required. Securing private sites under management and conservation agreements would be more effective than those on public land, as access is generally far more restricted and often there is only one stakeholder involved in management decisions, rather than several. This of course relies on the interests of the landowner being compatible with the objectives of the plan and the availability of privately owned remnant vegetation patches with a suitable buffer to afford protection from *Phytophthora cinnamomi*.

Over half the known threatened grasstree sites occur on private land and plants may be threatened by continuing land conversion, housing/development, habitat degradation, mining and trampling/grazing by stock. Private land owners need to be encouraged to participate in long-term conservation and management agreements in order to protect important populations, particularly those not or minimally infected by *Phytophthora cinnamomi*. There are currently no significant threatened *Xanthorrhoea* populations contained in private reserves or areas protected by conservation covenant.

Although grasstrees require fire to induce mass flowering events, plants are potentially threatened by inappropriate fire frequencies that interrupt the maturation cycle and result in the death of individuals. Fire frequency and intensity needs to be such that plants can sufficiently develop to survive the burn, or reproduce to ensure that recruitment can occur. The effects of adverse fire regimes may be compounded by failure of seedling recruitment due to inappropriate germination conditions. Further research needs to be conducted in order to determine what disturbance regimes are most beneficial.

A major limiting factor for the protection of *Xanthorrhoea arenaria* and *Xanthorrhoea bracteata* is their uncertain taxonomic status and the difficulty associated with identifying them in the field. Although the descriptions of the two species are quite different, *in situ* many plants display intermediate characteristics between all three Tasmanian *Xanthorrhoea* species. The difficulty in identification may be due to hybridisation and introgression within the Tasmanian *Xanthorrhoea* group and confounded by the possible co-occurrence of taxa. The irregularity in flowering complicates matters further, as identification calls for a flower spike containing various floral features in good condition. Due to possible hybridisation events, even if one flower spike can be collected from a 'population' it may not be representative of the group. Population data is therefore not entirely reliable and classification of these plants into groups by sites or localities is perhaps more relevant at this stage.

A permit is required to take threatened grasstrees across all land tenures. At present, there are no permit requirements for non-listed grasstrees on private land unless they occur in a threatened vegetation community. However, a permit is required for any vegetation to be removed or disturbed on land reserved under provisions of the *Nature Conservation Act 2002* or reserved under provisions of the *Crown Lands Act 1976*. Consideration should be given for listing all Tasmanian *Xanthorrhoea* species under provisions of the *Nature Conservation Act 2002* that would protect the species across all tenures.

Currently in Tasmania, *Xanthorrhoea australis* plants are harvested for florist foliage Brodribb (no date). Adverse impacts of this activity include scalping, which decapitates the plant completely (Phillips & Watson 1991) and increases the risk from *Phytophthora cinnamomi*. No applications have been submitted in order to

remove whole plants from Crown land, however, mainland studies indicate that an illegal market exists. The extent to which whole grasstrees are harvested in Tasmania is largely unknown and warrants investigation. Victorian authorities are faced with the issue of finding un-tagged plants for sale that harvesters or nurseries say are from Tasmania, as Tasmania has no tagging system. If genetic analysis is done on the genus as recommended under action 6, this will result in a tagging system, which can be used to determine whether plants are from Tasmania.

Due to the lack of data, at this stage it is difficult to outline priority sites and subsequent management prescriptions. Estimates of plant numbers are required to prioritise management and monitoring is essential to determine the response of *Xanthorrhoea* to disease and whether, or to what extent, populations are in decline.

Reservation Status

Reserved sites containing both *Xanthorrhoea bracteata* and *Xanthorrhoea arenaria* include Bridport Coastal Reserve, Little Boobyalla River Conservation Area, Waterhouse Conservation Area and Mount William National Park. The most significant reserve containing *Xanthorrhoea bracteata* is the Cameron Regional Reserve, however this area is not managed primarily for nature conservation values. The Coles Bay Conservation Area and Freycinet National Park are the most significant reserves for *Xanthorrhoea arenaria*. Regional and public reserves are not considered to provide a high level of protection for nature conservation values.

Species	Name of Reserve
<i>Xanthorrhoea</i> aff. <i>bracteata</i>	Boobyalla Public Reserve
<i>Xanthorrhoea</i> aff. <i>bracteata</i>	Emu Ground Forest Reserve
<i>Xanthorrhoea</i> aff. <i>bracteata</i>	Public Reserve
<i>Xanthorrhoea arenaria</i>	Public Reserve
<i>Xanthorrhoea arenaria</i>	Coles Bay Conservation Area
<i>Xanthorrhoea arenaria</i>	Freycinet National Park
<i>Xanthorrhoea arenaria</i>	Public Reserve
<i>Xanthorrhoea arenaria</i>	Public Reserve
<i>Xanthorrhoea arenaria</i>	Humbug Point Nature Recreation Area
<i>Xanthorrhoea arenaria</i>	Mount William National Park
<i>Xanthorrhoea arenaria</i>	Waterhouse Conservation Area
<i>Xanthorrhoea bracteata</i>	Cameron Regional Reserve
<i>Xanthorrhoea bracteata</i>	Public Reserve
<i>Xanthorrhoea bracteata</i>	Public Reserve
<i>Xanthorrhoea bracteata</i>	Little Boobyalla River Conservation Area
<i>Xanthorrhoea bracteata</i>	Mount William National Park
<i>Xanthorrhoea bracteata</i>	Waterhouse Conservation Area

Conservation Status and Habitat Critical to the Survival of Species

Xanthorrhoea arenaria and *Xanthorrhoea bracteata* are both listed as vulnerable under the *Threatened Species Protection Act 1995*. *Xanthorrhoea arenaria* is listed as Vulnerable, and *Xanthorrhoea bracteata* as Endangered on the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

Using Version 3.1 of the IUCN (World Conservation Union) Red List guidelines (2000), on current data the threatened *Xanthorrhoea* species both qualify for listing as Vulnerable on the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* under:

- Rule A. Reduction in population size based on an observed, estimated, inferred or suspected population size reduction of 30% over the last 10 years or three generations (up to 100 years). A continuing decline is inferred due to *Phytophthora cinnamomi*, land clearance and inappropriate firing.
- Rule C. Population size estimated to number fewer than 10,000 mature individuals and 1) an estimated continuing decline of at least 10% within 10 years or three generations and 2) no sub population estimated to contain more than 1000 mature individuals.

Under the *Threatened Species Protection Act 1995* there is support for listing *Xanthorrhoea australis* due to the rates of decline associated with *Phytophthora cinnamomi* infection though quantification of the decline rates is required.

Habitat considered critical to the survival of the species comprises:

- Sites of *Xanthorrhoea arenaria* and *Xanthorrhoea bracteata* on private land reserved by conservation covenant would be of the highest conservation value, due to the ability to manage *Phytophthora cinnamomi* more effectively at these sites. It is hoped that during the life of this Recovery Plan, such agreements will be secured.
- The Bridport Coastal Reserve, Waterhouse Conservation Area, Mount William National Park and Little Boobyalla River Conservation Area as they contain both *Xanthorrhoea arenaria* and *Xanthorrhoea bracteata*.
- The Bellingham/Pipers Brook site containing *Xanthorrhoea bracteata*, due its *Phytophthora cinnamomi* free status and manageable nature of the block.
- The Badger's Hill site in State Forest, which contains large numbers of *Xanthorrhoea bracteata* individuals and is a recommended area for implementing *Phytophthora cinnamomi* management prescriptions (Barker 1994, Schahinger *et al.* 2003).
- The population of *Xanthorrhoea arenaria* near Coles Bay is a well-known site with more than 2000 plants.

Existing Conservation Measures

Xanthorrhoea bracteata was included as part of a Recovery Plan for Selected Tasmanian Forest Associated Plants (Barker & Johnson 1998), however, this plan has never been adopted or implemented. There is currently one land purchase under the 1999 RFA Private Forest Reserves Program that contains threatened *Xanthorrhoea* species. Threatened *Xanthorrhoea* species only occur in 2 reserves (Freycinet National Park and Mt William National Park) that are managed primarily for their nature conservation values. The species is included in the Waterhouse Conservation Area Management Plan 2003.

Management prescriptions against the spread of *Phytophthora cinnamomi* have been developed for threatened *Xanthorrhoea* sites at Badger Hill, Little Boobyalla, Musselroe Bay, Mt William and the Waterhouse Conservation Area (for specific recommendations see Schahinger *et al.* 2003). If significant threatened *Xanthorrhoea* populations are discovered outside of these management areas, guidelines for assessing whether *Phytophthora cinnamomi* occurs at the site are available. The *Phytophthora cinnamomi* Management Manual (Rudman 2004) provides detailed planning advice for whether an area should be managed for the pathogen. It also outlines management prescriptions for scenarios such as fire. This manual provides guidelines to identify priority management areas that were not recognised as part of the initial review (Schahinger *et al.* 2003).

RECOVERY PLAN

Recovery Objectives, Performance Criteria and Actions Needed

The **overall objective** of the Recovery Plan is to determine the status of *Xanthorrhoea arenaria* and *Xanthorrhoea bracteata* and to minimise further decline of the species. This will require the management of existing populations, further survey and the protection of *Phytophthora cinnamomi* free populations through conservation covenants and land management agreements and taxonomic review.

Specific objectives are:

1. Prevent or minimise decline in known populations particularly with respect to management of *Phytophthora cinnamomi*.
2. Determine the extent of threatened grasstrees in Tasmania.
3. Develop a field-based identification system to enable appropriate management of all Tasmanian grasstrees.
4. Manage populations in the long term.

The **criteria** for achieving the objectives constitute a quantifiable decrease in the risk of extinction over 5 years of Recovery Plan implementation. They are:

1. No significant decline in the area occupied in each of the known populations due to land clearance (a key threatening process under the EPBC Act). **Specific objective 1**
2. The distribution and abundance of threatened grasstrees at all known sites have been mapped and threatening processes identified. **Specific objective 2 and 3**
3. At least 2 priority *Phytophthora cinnamomi* free sites (preferably containing both species) have been identified and are being managed. **Specific objective 1 and 4**
4. Improved security through management agreements (preferably with covenants signed) have occurred from discussions held with landowner/managers to secure populations in perpetuity. **Specific objectives 1 and 4**
5. Appropriate *Phytophthora cinnamomi* management has been implemented on all priority sites and standard management prescriptions have been developed specifically for the threatened Tasmanian grasstrees. **Specific objectives 1 and 4**
6. Data relating to *Xanthorrhoea* characteristics and distribution has been compiled and is easily accessible. **Specific objective 2 and 3**
7. Monitoring of populations has been conducted to determine the response of the species to *Phytophthora cinnamomi* and the disturbance requirements to maintain numbers or improve condition. **Specific objective 1 and 4**
8. Establishment of a Recovery Team when funding is procured to implement this plan or parts thereof. **Specific objective 4**

9. Update listing statements and spatial and population data as required and circulate this information to the wider botanical community and general public in the appropriate form i.e. update TSS databases, circulate updated information to the Tasmanian Flora Network and update the DPIW threatened species website as necessary, provide data to relevant State and Commonwealth agencies, and include threatened species sites on LIST (Land Information Systems Tasmania) to alert potential landowners as to possible restrictions by the end of year 1. ***Specific objective 4***
10. Specimens of each population lodged with the Tasmanian Herbarium by the end of year 1. ***Specific objective 3***
11. Annual requests made to volunteer networks (e.g. Wildcare, Threatened Species Network) to encourage active involvement in the Recovery process. ***Specific objective 1 and 4***
12. Maintenance of the TSS database (ie: new populations, population decline and threshold conditions) and annual assessment to determine whether management intervention is required. ***Specific objective 4***
13. Reassessment of the conservation status when information is available, storage of revised assessments in the TSS conservation status assessment database, and preparation of nominations for a change in status for State and Commonwealth legislation if a change in status is indicated. ***Specific objective 2 and 4***
14. Update the Recovery Plan by the end of 2010. ***Specific objective 4***

The **actions** required for achieving the objectives are:

1. Determine extent, abundance, threats and priority sites for conservation. ***Specific objective 1 and 2. Performance criteria 1, 2, 3, 6 and 9.***
2. Prevent decline in known populations ***Specific objective 1. Performance criteria 1, 3, 4, 5, 7, 11 and 12.***
3. Protection against changes in land-use. ***Specific objective 1 and 4. Performance criteria 1, 4, 5, 9, 11, 12, 13 and 14.***
4. Survey for new populations. ***Specific objective 2. Performance criteria 2 and 6.***
5. Determine appropriate disturbance needs for recruitment in populations and assist landowners/managers to manage habitat in order to maintain or increase population size. ***Specific objective 4. Performance criteria 4, 7, 9, 11, 12 and 14.***
6. Re-assess *Xanthorrhoea* taxonomy to develop a useable field identification system and protocols for dealing with hybridisation and species continuums. ***Specific objective 3. Performance criteria 2, 6 and 10.***
7. Re-assess the conservation status of all Tasmanian grasstrees. ***Specific objective 2 and 4. Performance criteria 2, 6 and 13.***
8. Long term management. ***Specific objective 4. Performance criteria 2, 3, 4, 5, 7, 8, 9, 11, 12, 13 and 14.***

Strategy for Recovery and Progress Evaluation

Due to the uncertain taxonomic status of the Tasmanian grasstrees, the focus of this plan is centred on practical management applications that can be implemented promptly. It is recognised that taxonomic and identification issues need to be resolved, allowing for reassessment of the conservation status of all three Tasmanian *Xanthorrhoea* species.

The Threatened Tasmanian Grasstrees Recovery Plan will run for 5 years and is based on strategies to maintain or increase numbers of individuals, habitat quality and to manage and protect populations in the long term. This will be achieved by improving security against changes in land-use, determining disturbance requirements, survey and monitoring, habitat management.

This plan has been prepared in consultation with various representatives of the Threatened Species Section and the Vegetation Section of the Biodiversity Conservation Branch (Department of Primary Industries and Water), and the Tasmanian Flora Network, a network of professional botanists and active volunteers concerned with threatened flora issues in Tasmania.

A Recovery Team will be established once funding to implement this plan or parts of the plan is secured. Each year following establishment, the Recovery Team will monitor and evaluate progress against recovery criteria outlined in this plan and report to relevant sponsor organisations. Information will be communicated to the general public through Listing Statement updates, relevant newsletters and reports.

This plan is consistent with the aims of the *Threatened Species Strategy for Tasmania* (2000) and *Tasmania's Nature Conservation Strategy* (2002).

Affected Interests and Social and Economic Impacts

Xanthorrhoea arenaria and *Xanthorrhoea bracteata* have legal protection as listed threatened species at the State and Commonwealth level. Close to half the known sites occur on reserved lands reserved under the *Nature Conservation Act 2002*.

The Aboriginal community is currently being consulted to determine whether there are any Aboriginal issues or interests identified in this Recovery Plan. If no role is identified for indigenous communities in the recovery of this species, opportunities may exist through cultural interpretation and awareness of this species.

The implementation of this Recovery Plan is unlikely to cause significant adverse social and economic impacts, as a primary aim of this recovery plan is to develop conservation covenants and management agreements with relevant land managing parties, particularly private landowners.

Biodiversity Benefits

As well as preventing these species from becoming extinct, biodiversity benefits include the maintenance of healthy forest communities that are threatened with further reduction in size and diversity through impacts such as land clearance (development and conversion) and *Phytophthora cinnamomi*. The habitat of these species include coastal heath and *Eucalyptus amygdalina* communities that provide habitat for a range other threatened species recorded with *Xanthorrhoea arenaria* and *Xanthorrhoea bracteata* including approximately 53 listed in the Tasmanian *Threatened Species Protection Act 1995* and 6 in the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The threatened *Xanthorrhoea* species play an important part in contributing to the unique biodiversity of the north and east coasts of Tasmania. Ongoing research into the conservation biology of this species is of relevance to the conservation of this species and other threatened flora species.

RECOVERY ACTIONS

1. Determine extent, abundance, threats and priority sites for conservation

Although basic distribution information is available for the threatened grass tree species, in order to assess the conservation status of these species accurately and determine management prescriptions, data is required to determine the identity, extent, abundance and threats at each known site. The condition of the vegetation is also a significant factor in determining appropriate management prescriptions. The most effective way to collect information is through surveys and monitoring.

Where possible, surveys should be undertaken during flowering time to assist in identification of the species and herbarium specimens should be collected from each occurrence unless previously collected. However, flowering can be erratic and as flower spikes may be absent, vegetative characteristics of the plants should be recorded as well as reproductive characteristics to assist in taxonomic review (action 7). Data and herbarium specimens should also be collected from the 'unusual' *Xanthorrhoea* populations at Sisters Beach and Arthur River to determine their relationship to *Xanthorrhoea arenaria* and *Xanthorrhoea bracteata*.

The area of occupancy, number of individuals and evidence of recruitment need to be recorded, as well as site specific information such as topography, edaphic features, vegetation community, condition etc. Threats such as *Phytophthora cinnamomi*, mining, potential for conversion, firewood collection and recreational four-wheel driving should also be identified. The outcome of survey will provide the Threatened Species Section (DPIW) with accurate polygon data containing detailed population information and an outline of threatening processes that are operating at each site. When surveys of the known localities have been completed, monitoring may need to be established at significant sites in order to determine recruitment rates in response to disturbance or management regimes. This will allow development of more effective advice for landowners/authorities to manage habitat in order to maintain or increase population size.

The survey data will enable the identification of priority sites for conservation. These sites may include both threatened species of *Xanthorrhoea* or an extensive example of one that is free or relatively free of infection from *Phytophthora cinnamomi*. The sites may also be selected due to their more manageable status, for example a population on private land with a pro-active landowner may have a higher priority for conservation than a public reserve with little control over access.

A Project Officer and Technical Assistant would be required for one year. Costs for this action include travel, survey and monitoring costs. Volunteer input may be sought. Co-ordination responsibility rests with DPIW.

Cost estimate	Timeframe
\$50,000	Year 1-5

2. Prevent significant decline in known populations

The major threat to the health of threatened *Xanthorrhoea* populations is infection from *Phytophthora cinnamomi*. Monitoring will be required to determine whether disease symptoms are present, and if so the response of the plants to infection. There is also a need for management prescriptions that cater specifically to threatened grass tree populations. These should include recommendations for infected sites and preventative measures if the population is either free or minimally infected by the pathogen.

The first step is to develop a fire management plan for each priority site. This will ensure that there is contingency for dealing with equipment and machinery in the event of fire and to ensure that appropriate measures are taken to avoid the spread of *Phytophthora cinnamomi* when controlling fires. In addition to this, an access plan should be formulated to minimise the risk of infection through traffic/vehicle movement. The development of these two plans will ensure that most generic *Phytophthora cinnamomi* problems are considered. Incorporation of information available in existing plans, such as the Waterhouse Conservation Area Management Plan 2003, should be a priority. Ongoing liaison with the Parks & Wildlife Service (DTAE) will be required in order to successfully develop fire management protocols.

Site specific issues may require additional planning eg. how to deal with activities that increase the risk of introducing and spreading *Phytophthora cinnamomi* such as woodcutting and 4-wheel driving. If the population occurs in a recognised *Phytophthora cinnamomi* management area, prescriptions for these sites have been prepared and should be implemented (Schahinger *et al.* 2003).

As part of this plan, it would be valuable to determine the viability of phosphonate treatments in threatened *Xanthorrhoea* populations that are experiencing decline through infection by *Phytophthora cinnamomi*. Little research has been conducted to date in Tasmania regarding the efficacy of phosphonate. The use of this chemical as a management tool is relatively detailed and involves a testing program to determine the right level and method of application and the monitoring of any adverse effects.

A possible management tool for regeneration of *Xanthorrhoea* species in *Phytophthora cinnamomi* affected areas can be seen in the context of the Brisbane Ranges National Park in Victoria (Weste *et al.* 1999). Monitoring indicates that regeneration of *Xanthorrhoea australis* has occurred in an infected site after severe fire swept through the site in 1967. As a Tasmanian case study, it may be worthwhile investigating if any regeneration has occurred at Rocky Cape, which is also infected by *Phytophthora cinnamomi* and was burnt 3-4 years ago. Fire may be a possible future management tool for *Phytophthora cinnamomi* infected sites that contain Tasmanian threatened *Xanthorrhoea* species.

Other possible causes of decline, such as insufficient or excessive disturbance or fire also needs to be investigated. Monitoring results will need to be interpreted to distinguish between true decline and natural fluctuation within populations and to determine the degree of decline that should trigger management intervention. If plant numbers or the areas occupied are low or declining, intervention through implementation of management prescriptions will be required to address the deficiency.

Costs for this action include travel and data collection and handling costs as well as co-ordination costs. Resources should also be allocated to phosphonate research. Volunteer input will be sought. Co-ordination responsibility rests with DPIW.

Cost estimate	Timeframe
\$80,000	Year 1-5

3. Protection against changes in land-use

Significant populations of *Xanthorrhoea* occur on private land and are at risk of destruction by conversion through agriculture, housing, forestry activities or roading etc. To prevent the inadvertent destruction of populations, current landowners and managers need to be made aware of their responsibilities under the Tasmanian *Threatened Species Protection Act 1995*, if not already informed. Where populations are thriving, mechanisms to maintain current land use need to be pursued with landowners, with various options and associated incentives explored. One option for private land is a voluntary management agreement with the State Government. These are usually for a fixed term e.g. five or ten years and specify management obligations that are binding both on landowners and on the Department of Primary Industries and Water. Ideally, sites containing healthy populations of both threatened *Xanthorrhoea* species or large, healthy populations of either *Xanthorrhoea arenaria* or *Xanthorrhoea bracteata* on private land should be targeted for protection through such agreements.

There is currently no general provision to alert new or potential landowners to the presence of protected species on private land. There are some mechanisms available to register this information on the land title to enable it to travel with the title to future owners. This would be beneficial to the species, as it would help prevent the inadvertent destruction of populations with a change of ownership. The mechanisms are either a conservation covenant or creation of a private reserve. These are voluntary conservation agreements between the State Government and the landowner. Conservation covenants can only be modified or revoked with the agreement of the landowner and relevant Minister(s). One type of private reserve, a Private Sanctuary, can be revoked at the request of the landowner. The other type of private reserve, a Private Nature Reserve, can only be revoked with the consent of both Houses of Parliament. Options to provide incentives for landowners to take up covenants on land with threatened grasstrees need to be explored.

Given that much of the potential coastal habitat is on land suitable for subdivision, to avoid past problems a process is required to ensure that surveys for the species are requested by relevant local councils prior to subdivision applications being submitted or approved. Dealing with the presence of threatened species prior to plans being drawn up would be beneficial to developers as well as other parties.

Mining is ongoing in certain areas within the distribution of the species. Mining activities can take place in Nature Recreation Areas, Regional Reserves, Forest Reserves, Conservation Areas or on private land. Liaison will need to be maintained to ensure that future mining activities are not detrimental to the species.

Costs for this action include services to promote and facilitate voluntary conservation agreements (including incentives) between land owners with occurrences of threatened *Xanthorrhoea* species and the Tasmanian Government. The services will be provided through DPIW programs including the Private Property Conservation Program and Land for Wildlife. Costs also include liaison between DPIW and councils and mining bodies. Co-ordination costs are additional. Responsibility rests with DPIW.

Cost estimate	Timeframe
\$100,000	Year 1-5

4. Survey for new populations

The number of populations that are free of *Phytophthora cinnamomi* needs to be increased. New sites containing either or both *Xanthorrhoea arenaria* and *Xanthorrhoea bracteata* have been discovered since the species were first included in the Recovery Plan of Barker and Johnson (1998). Potential habitat exists on both private and Crown land that has not been thoroughly surveyed. The prospect of finding new populations that are free or minimally infected is considered to be low. Reports of new occurrences will also require verification.

Through DPIW projects there is potential to locate new sites for threatened grasstrees, for example continuing *Phytophthora cinnamomi* work and survey associated with various programs such as Land for Wildlife and the Private Property Conservation Program. The wider botanical community should be encouraged to report potentially significant sites.

Another mechanism by which new populations may be located includes aerial health surveillance through Forestry Tasmania. These surveys are conducted annually and through this process, it may be possible to assess the distribution and health of *Xanthorrhoea* populations. This type of observation would allow the accumulation of more information on *Xanthorrhoea* distribution than is possible through ground survey. In many instances the forest communities in which grasstrees occur may be quite open, resembling woodlands. It may also be possible to detect symptoms of *Phytophthora cinnamomi* through aerial survey. If *Xanthorrhoea* populations in State forest could be mapped aerially, this would provide accurate target areas in which to survey for threatened grasstree species.

Staff within the Forest Practices system identify threatened *Xanthorrhoea* species through their inclusion as 'sites of significance' in the Forest Botany Manuals. Within relevant regions, the plants are listed in the Coastal/Sub Coastal *Eucalyptus amygdalina* forest community. Forest Practices Authority staff are notified when threatened *Xanthorrhoea* species are located and new sites can be recorded. Field assessment of the

coups also includes forest health, which is an important component when dealing with infection from *Phytophthora cinnamomi*.

With effective liaison between DPIW and other relevant parties (eg. Forestry Tasmania, private consultants etc.) new population locations can be forwarded to TSS and included in the threatened flora database. Sites can be verified if necessary and assessed to determine the most effective system of management.

This Recovery Plan identifies the need for further surveys and funding may be best utilised through a cooperative approach between DPIW, the Forest Practices Authority, Forestry Tasmania and private consultants. Over the extent of the 5 year Recovery Plan, a strategy may be devised through collaboration with relevant authorities that aims to survey of all priority areas of potential habitat for threatened *Xanthorrhoea* species in State Forest.

Costs for this action include travel, survey and verification costs. Volunteer input will be sought. Co-ordination responsibility rests with DPIW.

Cost estimate	Timeframe
\$20,000	Year 1-5

5. Determine appropriate disturbance needs for recruitment in populations and advise and help landowners/managers to manage habitat in order to maintain or increase population size

Whilst fire is a vital part of reproduction and successional development in *Xanthorrhoea* species, trials will need to be conducted to determine optimal disturbance requirements to encourage recruitment in threatened grasstree populations. These requirements may vary depending on whether the plants occur in coastal heath or forest communities.

The susceptibility of threatened grasstrees to herbivory is unknown. Losses through grazing will need to be monitored to determine whether protection of germinants is required, particularly for small, fragmented populations. Protection from grazing can be through fencing or brush coverings if it is deemed to be problematic.

Should monitoring determine that plant numbers or area occupied are low or declining, intervention is required if a cause or a remedy can be identified. The degree of decline that should trigger management intervention will need to be determined. Possible intervention includes firing, slashing, fencing etc. Habitat management intervention will be negotiated with owners of land with occurrences of threatened *Xanthorrhoea* species and where appropriate, written management advice will be provided.

Costs for this action include travel and co-ordination costs with preparation of management advice and co-ordination and costs associated with application of treatments. Volunteer input will be sought. Monitoring will be covered by action 1 of this plan. Co-ordination responsibility rests with DPIW.

Cost estimate	Timeframe
\$20,000	Year 1-5

6. Reassess *Xanthorrhoea* taxonomy to develop a useable field identification system and protocols for dealing with hybridisation and species continuums.

Although floral characteristics of *Xanthorrhoea* species in Tasmania have been well defined, the morphology of the foliage also requires investigation, as floral material may not be available in some seasons. Cross sections should be taken from leaves and the cell morphology analysed. However, the development of a key to identify grasstrees needs to consider the issue of hybridisation. A revision of *Xanthorrhoea* morphology would be best aided by genetic research (e.g. chloroplast DNA) to determine whether a relationship exists between morphological variation and genetic variation in the field. Molecular studies would also provide a more definitive answer with respect to hybridisation. This could be conducted in conjunction with postgraduate research (PhD candidate) through the University of Tasmania or by contracting one of the botanical genetic research laboratories that operate within Australian universities.

In order to reassess the conservation status of the threatened grasstrees, further investigation is required to determine whether or not hybridisation or a continuum occurs between *Xanthorrhoea arenaria*, *Xanthorrhoea bracteata* and *Xanthorrhoea australis*. It is necessary to develop a workable key that allows for the identification of the species in the field. Due to the erratic flowering of *Xanthorrhoea* the key should not rely solely on flowers for species identification. Given the degree of variation encountered and variation that can be continuous, a workable key may not be able to be developed. As all these taxa share similar habitat and are exposed to similar threats and declines, the protection of all Tasmanian grasstree taxa under provisions of the *Threatened Species Protection Act 1995* or the *Nature Conservation Act 2002* could be considered. This would have the additional benefit of resolving some of the identification issues.

The taxonomic identity of the 'unusual' *Xanthorrhoea* plants at Sisters Beach and Arthur River in the northwest of the State also requires investigation. Material from these sites should be collected and submitted to the relevant herbaria and may need to be incorporated in a taxonomic review of the genus in Tasmania.

Costs for this action include employment of a project officer, technical assistant and resources for the contract of molecular research (or contribution to a PhD project through University of Tasmania). Volunteer input will be sought. Co-ordination responsibility rests with DPIW.

Cost estimate	Timeframe
\$60,000	Year 1-5

7. Reassess the conservation status of all Tasmanian grasstrees

A reassessment of the conservation status of *Xanthorrhoea* taxa in Tasmania is required following the resolution of the taxonomic issues noted above. Current data is deficient and previous assessments have been based on limited information. Populations of *Xanthorrhoea australis* are subject to continued declines due to *Phytophthora cinnamomi* infection. Therefore, the conservation status of *Xanthorrhoea australis* should also be assessed as it may now meet the criteria for listing. While both *Xanthorrhoea arenaria* and *Xanthorrhoea bracteata*, are listed as vulnerable on the TSP Act, their differing status on the EPBC Act is questionable (*X. arenaria* is currently listed as Vulnerable and *X. bracteata* is currently listed as Endangered).

The reassessment process will include determination of the conservation status of *Xanthorrhoea* taxa using rules or suitably modified rules for classification into 2001 IUCN Red List categories and documentation of qualifying rules. Inclusion of taxa on appropriate schedules of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and the Tasmanian *Threatened Species Protection Act 1995* should occur within 2 years of assessment.

Cost estimate	Timeframe
\$15,000	Year 1-5

8. Long term management

This action involves collation and interpretation of data pertaining to the threatened grasstrees and dissemination to stakeholders in the appropriate form. This is necessary to base management advice, allocation of resources and assessment of the impact of development proposals on the best available information at any time. This action is also required to encourage and allow community participation in and ownership of the Recovery Plan implementation process.

Ongoing data and data interpretation requirements as new information becomes available are:

- entry of spatial information into TSS and DPIW GIS systems
- collation of additional information required to assess the conservation status, such as population and threat data and inclusion in a TSS database
- regular reassessment of conservation status, storage of revised assessments in a TSS database and preparation of nominations for a change in the conservation status for State and Commonwealth legislation as required
- Entry into TSS database (ie: new populations, population decline and threshold conditions) and regular assessment of database to determine whether management intervention is required
- lodgement of specimens of each population with the Tasmanian Herbarium in case of future taxonomic treatments

Requirements for the dissemination of information are:

- prepare Listing Statements and update every five years or as new information becomes available and circulate to libraries, the wider botanical community (including the Tasmanian Flora Network) and include on the TSS website to give access to the general public
- update the Recovery Plan every 5 years, submit for adoption by the State and Commonwealth, and circulate to libraries, the wider botanical community (including the Tasmanian Flora Network) and include on the DPIW and Commonwealth websites to give access to the general public
- update written management advice on populations to landowners/managers as necessary
- circulate spatial information to different users in the appropriate form i.e. include polygon or point data as appropriate in the TSS GIS system, include point records in the DPIW GIS system, provide data to relevant State and Commonwealth agencies, include polygon or point data as appropriate on the LIST (Land Information Systems Tasmania)
- investigation of additional processes to alert potential landowners as to possible occurrences of threatened flora species and associated responsibilities

Mechanisms to facilitate community participation and ownership are:

- establish a Recovery Team when funding is procured to implement this plan or parts thereof
- make requests to volunteer networks (eg. Wildcare, Threatened Species Network) to participate in specific recovery actions at least 6 weeks in advance (general requests for participation usually generate little interest)
- request participation in recovery actions by the wider botanical community through the Tasmanian Flora Network
- when necessary, organise permission from landowners/managers to access populations and permits from the TSS for the collection of material for identification or for herbarium specimens

Costs for this action include those associated with maintenance of databases and websites, updates and circulation of literature, requests for participation in the Recovery Team and recovery actions including provision of training and supervision when necessary and other co-ordination costs. Responsibility rests with DPIW.

Cost estimate	Timeframe
\$22,000	Year 1-5

BIBLIOGRAPHY

- Barker, P.C.J. (1994).** *Phytophthora cinnamomi: The susceptibility and management of selected Tasmanian rare species.* Forestry Tasmania and Australian Nature Conservation Agency, Tasmania.
- Barker, P.C.J. & Johnson, K. (1998).** *Recovery Plan - Selected Tasmanian Forest Associated Plants,* Forestry Tasmania, Hobart.
- Barker, P.C.J. & Wardlaw, T.J. (1995).** Susceptibility of Selected Tasmanian Rare Plants to *Phytophthora cinnamomi*, *Australian Journal of Botany*, Vol.43, pp.379-386.
- Brodrigg, T. (no date).** Determination of Harvestable Yield in *Xanthorrhoea*. Unpublished report. University of Tasmania, Hobart.
- Buchanan, A.M. (2005).** *A Census of the Vascular Plants of Tasmania & Index to The Student's Flora of Tasmania.* Fourth Edition. Tasmanian Herbarium Occasional Publication No. 7, Tasmanian Museum and Art Gallery, Hobart
- Curtis, W.M. & Morris, D.I. (1994).** *The Student's Flora of Tasmania*, Part 4. University of Tasmania, Hobart.
- Environment Australia (2000).** Revision of the Interim Biogeographic Regionalisation of Australia (IBRA) and the Development of Version 5.1. – Summary Report. Department of Environment and Heritage, Canberra
- Flora of Australia (1986).** *Volume 46: Iridaceae to Dioscoreaceae,* Australian Government Publishing Service, Canberra.
- Lamont, B.B. & Downes, S. (1979).** 'The Longevity, Flowering and Fire History of the Grasstrees *Xanthorrhoea preissi* and *Kingia australis*'. *Journal of Applied Ecology*, Vol.16, pp.893-899.
- North Barker Ecosystem Services (2004).** Coles Bay Camping Ground. Botanical and Fauna Habitat Extension Survey. A report to the Property Development Branch, Department of Primary Industries, Water and Environment, Hobart.
- Phillips, A. & Watson, R. (1991).** *Xanthorrhoea*: Consequences of 'Horticultural Fashion', *Victorian Naturalist*, Vol.108 (6).
- Pole, M. (1994).** *Review of Australian species of genus Xanthorrhoea (Xanthorrhoeaceae).* Conservation Commission of New South Wales.
- Rudman, T. (2004).** Interim *Phytophthora cinnamomi* Management Guidelines, Nature Conservation Branch, Department of Primary Industries, Water and Environment, Hobart.
- Schahinger, R., Rudman, T. & Wardlaw, T. (2003).** *Conservation of Tasmanian Plant Species and Communities Threatened by Phytophthora cinnamomi.* Nature Conservation Branch Technical Report 03/03, Department of Primary Industries, Water and Environment, Hobart.
- Staff, I. (1974).** The Fruit and Seed Productivity in *Xanthorrhoea*. *Proceedings of the Linnean Society of New South Wales*, Vol.100, Part 1.
- Tasmanian Flora Advisory Committee (1994).** *Native Higher Plant Taxa which are rare or threatened in Tasmania. Edition 1, Species at risk in Tasmania – Flora.* Parks and Wildlife Service, Tasmania.
- Tasmania's Nature Conservation Strategy: 2002–2006 (2002).** Department of Primary Industries, Water and Environment, Hobart.
- Tasmanian Public Land Use Commission (1997).** *Process and guidelines for determining the conservation*

requirements for priority flora species in the Tasmanian CRA. Supplement to Environment and Heritage Report Vol VI. PLUC, Hobart.

Threatened Species Strategy for Tasmania (2000). Department of Primary Industries, Water and Environment, Hobart.

Weste, G., Walchhuetter T. & Walsh, T. (1999). Regeneration of *Xanthorrhoea australis* following epidemic disease due to *Phytophthora cinnamomi* in the Brisbane Ranges Victoria, *Australasian Plant Pathology*, Vol.28, pp.162-169.

Whelan, R.J. (1995). *The Ecology of Fire.* Cambridge University Press, New York.

Appendix 1. Distribution of *Xanthorrhoea* species in Tasmania (DPIW 2006)

