5

5.1 Conservation and rehabilitation of the natural and cultural heritage

What's in this chapter?

This chapter reports on the state of conservation of the natural and cultural heritage of the TWWHA, in particular focusing on the condition of significant values and any changes in condition that were detected over the 1992–1999 period.

Conservation is taken to mean maintaining the condition of the World Heritage and other natural and cultural values of the area. Rehabilitation is taken to mean repairing degraded sites and values so as to restore the former natural and cultural values of an area.

Contents

At a glance…key findings of this chapter

The natural diversity and processes of the TWWHA are largely in very good condition apart from a limited number of sites of specific disturbances (such as roads and dams) and the occurrence of plant diseases, weeds and introduced animals in some areas. The extent and severity of sheet erosion on the Central Plateau, which has been linked to past fire and grazing practices, remains a significant impact on the natural heritage of the TWWHA. Significant emerging issues for the conservation of ecosystems and biological communities are the widespread lack of regeneration of the fire-sensitive endemic pencil pine (*Athrotaxis cupressoides*) on the Central Plateau; and a noticeable decline in the health of eucalypt woodlands throughout Tasmania (See Section 5.2 'Condition of natural diversity and processes').

The vast majority of the TWWHA is of extremely high wilderness quality, and there was no significant change in wilderness quality over the 1992–1999 period (see Section 5.3 'Wilderness quality').

Air and water quality in the TWWHA is generally very high, although there are localised water quality problems due to poor sanitation. Macquarie Harbour continues to be affected by heavy metals and acidic drainage from the heavily polluted King and Queen Rivers—a legacy of past mining activities at Mount Lyell (see Section 5.4 'Environmental quality').

Active rehabilitation of a range of degraded sites achieved considerable local improvements in landscape quality and the aesthetic quality of viewfields (see Section 5.5 'Landscape quality').

Aboriginal sites within the TWWHA generally remained in a stable condition, with the notable exception of some midden sites along the south and west coasts, which were lost as a result of natural coastal erosion processes (see Section 5.6.1 'Aboriginal heritage').

Convict heritage on Sarah Island and associated sites was well maintained over the 1992–1999 period and is in a stable condition. Historic huts throughout the TWWHA that continued to provide a public recreational facility were well maintained and are mostly in a stable condition. However, lack of maintenance was associated with deterioration in the condition of some other historic huts and features (see Section 5.6.2 'Historic heritage').

Improvements in the condition of natural values over the 1992–1999 period included:

The water quality and ecology of the Exit Cave area markedly improved following the closure and rehabilitation of the nearby major limestone quarry at Lune River (see Section 5.7.1 'Karst system at Lune River').

The population size of the endangered Pedder galaxias fish significantly increased, and active management measures have probably saved the species from extinction (see Section 5.7.3 'Endangered species: Pedder galaxias fish').

The breeding range and production of the New Zealand fur seal (listed as rare under the Tasmanian *Threatened Species Protection Act 1995*) increased (see Section 5.7.6 'Rare species: New Zealand fur seal').

An increase in knowledge about the distribution of several species listed under the Tasmanian *Threatened Species Protection Act 1995* led to an improvement in their conservation status (see Sections 5.7.4 and 5.7.5).

Declines in the condition of natural values included:

The endangered orange-bellied parrot continued to decline in overall numbers and distribution, although the breeding population at Melaleuca remained stable over the 1992–1999 period (see Section 5.7.2 'Endangered species: Orange-bellied parrot').

The high conservation value of several natural aquatic ecosystems was degraded by the illegal introduction and establishment of trout in these formerly trout-free waterways (see Section 5.2.2 under the subheading 'Wetlands, aquatic and riparian ecosystems').

Some natural ecological communities were degraded by the spread of introduced plants and animals, and the root rot disease *Phytophthora cinnamomi*.

Riverbanks in the middle Gordon River continued to be eroded as a result of the regulation of river flows by hydro-electric power generation activities.

5.2 Condition of natural diversity and processes

Key Desired Outcome addressed in this section:

KDO 4.1: Maintenance or restoration of natural diversity and processes.

Natural diversity refers to the range of earth features and physical processes (geodiversity) and of indigenous flora and fauna (biodiversity) within the TWWHA.

The information on the condition of natural diversity and processes presented in this chapter has been provided by specialist staff with professional expertise in geoconservation, flora or fauna. These staff are employed in the Nature Conservation Branch of the Resource Management and Conservation division of the Department of Primary Industries, Water and Environment (DPIWE).

Dolerite columns are a feature of many of the higher mountain peaks in the TWWHA.

Photo by PWS

Exposed quartzite cliffs near the Mt McCall track.

Photo by Glenys Jones

5.2.1 Condition of geodiversity

Geodiversity is defined as the natural range of geological (bedrock), geomorphological (landform), and soil features, assemblages, systems, and processes. Geodiversity includes evidence for the history of the earth (evidence of past life, ecosystems and environments) and a range of processes (biological, hydrological and atmospheric) currently acting on rocks, landforms and soils.

Geodiversity in the TWWHA is largely in very good condition with natural rates and magnitudes of change in geomorphological and soil systems continuing unhindered. Most of the human induced threats have been, or are being, dealt with effectively as detailed in Chapter 4. The main impacts to geodiversity dealt with in this section relate to soil erosion.

The extent and severity of sheet erosion on the Central Plateau (which has been linked to past fire and grazing practices) remains a significant impact on the geoconservation values of the TWWHA. A study of sheet erosion on the Central Plateau (Cullen, 1995) revealed that in excess of 10,000ha was degraded through erosion, including 161ha of extreme erosion where more than 70% of the area was bare ground (see Figure 16). The extensive sheet erosion on the Central Plateau has been described as 'the worst alpine erosion in Australia'. Trials of rehabilitation techniques have been commenced to address this problem.

Repetitive burning of moorland has also been linked with the loss of massive volumes of organic peat soils over very large areas. It is estimated that more than 344 km^2 (34,400ha) or 43% of the Birchs Inlet area is eroded and a total of 100,000ha of moorland (20%) within the TWWHA has been degraded by peat loss caused by fire.

This aerial photograph of Wild Dog Tier shows the extensive nature of serious sheet erosion on the Central Plateau.

Remnant pedestals of vegetation indicate past soil levels in this seriously eroded site on the Central Plateau.

Photos by Michael Comfort

CHANGES IN THE CONDITION OF GEODIVERSITY OVER THE 1992–1999 PERIOD

Improvements in the condition of geodiversity detected over the 1992–1999 period included improvement in the biophysical condition of the Exit Cave area following closure and rehabilitation of the nearby major limestone quarry at Lune River (Bender's Quarry). See Section 5.7.1 'Karst system at Lune River'.

Declines in the condition of geodiversity over the 1992–1999 period included:

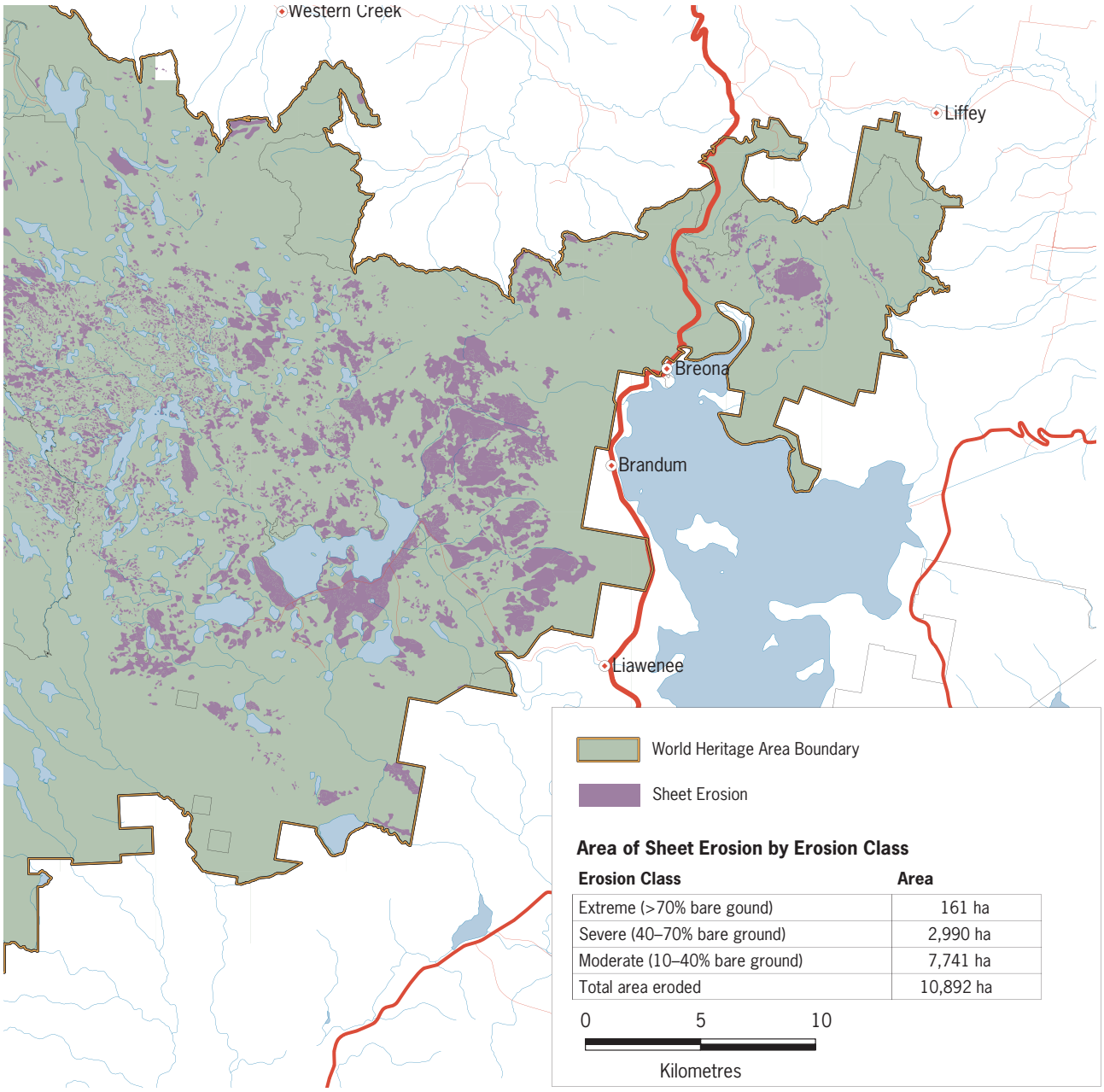
- Large-scale erosion of Pleistocene bank materials continued in the middle Gordon River below Gordon Dam (see Section 4.14 'Regulation of river flows by hydroelectric power generating operations').
- Some mineral specimens were illegally removed e.g. at Mt Oakleigh and Crystal Cave (see Section 2.5.2 'Law enforcement and compliance issues').
- There was a reduction in the integrity of the significant glacial moraines at Cynthia Bay, Lake St Clair as a result of construction of a Visitor Centre, accommodation cabins, car parks and other facilities.

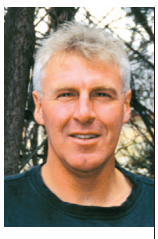
Figure 16

Sheet erosion on the Central Plateau

The extent and severity of sheet erosion on the Central Plateau (which has been linked to past fire and grazing practices) remains a significant impact on the geoheritage values of the TWWHA.

Source: Cullen (1995)





Phil Cullen (Project Officer, Earth Science Section) commenced work with the department in 1991 to implement the Central Plateau Soil Erosion Project. Phil went on to become involved in surveys of the Southwest coastal dunes and marram grass, and more recently undertook investigations into fire regimes in peatlands over the last 6,000 years—a project aimed at gathering information to assist sustainable fire management in the TWWHA. Phil is now working in land conservation management with the Australian Bush Heritage Fund.

Photo by Sophie Underwood

High glaciated country in the Mt Anne area. The razor sharp ridges were formed by the movement of past glaciers on either side of the divide.

Photo by Barry Batchelor

5.2.2 Condition of biodiversity

ECOSYSTEMS REPRESENTED IN THE TWWHA

The table below presents a summary of the major ecosystems of Tasmania and the extent to which they (and their component communities) are represented within the TWWHA.

Major Ecosystems of Tasmania and within the Tasmanian Wilderness World Heritage Area

Ecosystems	In Tasmania		In the TWWHA			
	Current extent (ha)1	No of communities described[1]	Extent (ha)[2]	Percentage of TWWHA	No of described communities recorded[1]	Percentage of described communities in the TWWHA
Rainforest	619,460	39	273,477	20%	33	85%
Eucalypt forest, mixed forest and woodlands	2,492,000	107	401,109	29%	46	43%
Swamp forest	39,000	29	Not available	Not available	Not available*	Not available
Grassland	51,000	39	2490[3]	0.2%	13	33%
Buttongrass moorland, scrub, & lowland heath	1,140,000	39	439,515	31%	26	66%
Coastal (including rookeries, grasslands, saltmarsh and heath communities)	222,510	91	5,504	0.5%	21*	23%
Alpine and subalpine vegetation	202,350	43	188,599 (excluding grassland)	14%	42	97%
Wetland and riparian (not salt marsh or marine)	24,500	76	8,289	1%	8*	10%
Other (including cleared areas, rock screes, lakes, and other vegetation not within the World Heritage Area)	1,997,910	Not applicable	77,426	5%	Not applicable	Not applicable

1. Source of data: Kirkpatrick et al. 1995.

2. Data provided for this report by Colin Reed GIS unit, DPIWE (analysis of mapping units from the TWWHA complex and simple vegetation mapping series by Corbett et al. based largely on photointerpretation of 1988 1:25,000 colour aerial photography).

3. Balmer & Whinam 1991.

* Further survey work is likely to lead to the identification of a greater range of communities within the TWWHA.

Condition of ecosystems and biological communities

Apart from sites of specific disturbances and the expansion of weeds, diseases and feral animals in some areas, the condition of most plant species, vegetation communities, fauna and fauna habitat in the TWHHA is in good condition and has generally remained stable over the 1992–1999 period. Most of the vegetation and fauna habitat of the TWWHA was managed effectively and/or was remote enough from human interference to be largely unaffected by humans and there were no major wildfires over the period.

The following general observations are of significant concern as emerging issues for the conservation of ecosystems and biological communities of the TWWHA and for all Tasmania:

- There was a widespread lack of regeneration of the fire-sensitive endemic pencil pine (*Athrotaxis cupressoides*). See 'Rainforest and coniferous woodlands' below.
- Throughout Tasmania (including the TWWHA) there was a noticeable decline in the health of eucalypt woodlands over the 1992–1999 period. See 'Eucalypt forest and woodland' below.

Detailed information about the condition of specific communities in the TWWHA is provided in the following sections.

GRASSLAND COMMUNITIES

About 4% (2,490ha) of Tasmania's temperate grassland occurs within the TWWHA. The conservation value of native grassland in Cradle Mountain–Lake St Clair National Park has been degraded by the construction of new huts, walking tracks, a Visitor Centre, and the installation of services on some of the best examples of montane grasslands throughout the Park. The biodiversity values of montane grasslands were also not enhanced by fire management practice over the period, which excluded fire and so prevented the maintenance of inter-tussock spaces critical for the perpetuation of herb species. Over the 1992–1999 period less than a hectare of montane grasslands was burnt. The rare plant species *Leucochrysum albicans* var. *tricolor* (hoary sunray)—which was known to occur in grasslands within the Cradle region in the early part of the 19th century—has not been recorded in recent surveys and is presumed to have become locally extinct.

Christmas bells (*Blandfordia punicea*) occur in moorlands and subalpine heaths. They normally flower at Christmas time (hence their common name) and may also put on a mass display of flowers following a fire.

Photo by Barry Batchelor

ALPINE AND TREELESS MONTANE COMMUNITIES

Tasmania's alpine ecosystems are amongst the most pristine in the world and also provide outstanding examples of species diversity, endemism and major evolutionary processes. About 70% (191,156ha) of Tasmania's alpine and montane vegetation is contained within the TWWHA.

Weed infestation in the TWWHA is largely limited to roadsides and huts within the Central Plateau Conservation Area with the exception of ragwort (*Senecio jacobaea*) which is also scattered through the western lakes.

Many areas of alpine and montane vegetation have been degraded as a result of past fires. For example, in the 20-year period between 1960 and 1980, about 16.1% of alpine areas in Tasmania were burned (Brown et al. 1983). A combination of fire and grazing has degraded about 10,892 ha or 7.5% of the Central Plateau during this period. This degradation had occurred prior to the 1992–1999 period. Grazing by rabbits continues to cause serious impacts. Significant areas of the Central Plateau are affected by serious sheet erosion (see Section 5.2.1 'Condition of geodiversity').

The removal of a number of pressures on alpine and montane communities over the 1992–1999 period is leading to some recovery of damaged vegetation. Stock grazing ceased under the provisions of the 1992 management plan and feral goats have been eradicated. Similarly changes in horseriding practices have reduced associated impacts over the period (see Section 4.10.4 'Case study—Horseriding on the Central Plateau').

Some areas of alpine and montane vegetation that were degraded as a result of fire and/or grazing, tracks and roads or other developments were revegetated over the 1992–1999 period and other areas are stabilising naturally—however the rates of recovery are very slow.

Wildfires within the 1992–1999 period caused degradation and loss of 55 hectares of montane or alpine vegetation including some sphagnum peatlands. Increases in fire frequency have resulted in buttongrass moorland replacing some *Sphagnum* peatlands in parts of the Wild Rivers National Park.

Other localised declines in the condition of alpine and montane communities over the 1992–1999 period occurred as a result of human developments (e.g. the construction of radio towers, cairns, tracks, huts etc)—see Section 4.11 'Development of new facilities and other infrastructure' and the formation of unplanned walking tracks as a result of trampling by walkers (see Section 4.10.3 'Case study—Walker impacts').

With respect to other emerging threats, it is generally acknowledged that alpine vegetation will be affected by global climate change. Tasmanian's alpine flora contains relatively few alpine obligates and so may be less affected than other floras where species show a more restricted climatic range. It is possible that some restricted plant communities (such as snow patch communities) may be lost from the landscape. With the exception of three endemic skinks, no vertebrate animals are restricted to alpine environments of Tasmania. These alpine skinks show unique adaptations to what is a very challenging environment for a reptile and could be expected to be lost as a result of global climate change. Many invertebrate species are restricted to alpine areas of Tasmania.

RAINFOREST AND CONIFEROUS WOODLANDS

Rainforest occupies about 20% (274,000 ha) of the TWWHA. Rainforest is a significant conservation asset because it is a stronghold for endemic plant and animal taxa with ancestral connections with the taxa of the super-continent of Gondwana. Rainforests within the TWWHA contain extensive stands of the fire sensitive endemic conifer species (14,196 ha or 42% of all King Billy forests and 7,666ha or 73% of all Huon pine forest; 23,357ha[43] of pencil pine communities, and 7,484ha or 70% of deciduous beech communities.

About 2 % of the rainforests within the TWWHA has been recently degraded by fires, but the overall proportion of fire-killed conifer communities is much higher with at least a third of King Billy forests in Tasmania having been destroyed by fire. Fire was largely excluded from rainforest within the TWWHA during the 1992–1999 period with just 20 hectares of rainforest and mixed forest having been burnt during this period.

Some communities of pencil pines, Cheshunt pines, and myrtle-beech were affected by plant diseases over the 1992–1999 period. See Section 4.7 'Plant diseases and dieback'.

There was a widespread lack of regeneration of pencil pines (*Athrotaxis cupressoides*) within the coniferous woodlands of the Central Plateau over the 1992–1999 period. This observation is of significant concern for conservation of these communities. Rabbit grazing, drought and/or climate change are thought to be possible causes.

EUCALYPT FOREST AND WOODLAND

Eucalypt forest and woodland occupies about 401,100ha (29%) of the TWWHA. With more than two thirds of this community being represented by mature old-growth forest, this community is of high conservation value. Eucalypt forest supports a greater diversity of fauna than any other habitat type in Tasmania. Most invertebrate groups show a high degree of endemicity, particularly taxa with low dispersal such as flatworms, earthworms and amphipods.

There was a noticeable decline in the health of eucalypt woodlands throughout Tasmania (including the TWWHA) over the 1992–1999 period. There are significant areas of eucalypt dieback within the TWWHA (notably at the entrance to Cradle Mountain) and also canopy thinning due to leaf shedding (notably in the Labyrinth). It appears that the dieback and poor health of eucalypts may be related (at least in part) to climatic change with a series of hot dry summers. Ageing populations are also a possible contributing factor for some of the observed dieback.

A relatively small amount of eucalypt forest was burnt over the period of the plan (about 667ha).

Milligania in flower. *Milligania* occurs in alpine herbfields and is one of 20 endemic plant genera in Tasmania.
Photo by Barry Batchelor

Contrasting foliage and forms create aesthetic complexity in this rainforest scene, which features the distinctive head of a Pandani, the glossy smooth leaves of a native laurel, and the moss- and lichen-encrusted trunks of young rainforest trees.
Photo by Glenys Jones

An ancient myrtle (*Nothofagus cunninghamii*) on the Sawback Range Track. Myrtles are the dominant rainforest species in Tasmania and are widespread in the TWWHA.
Photo by Barry Batchelor

43 A percentage is not provided here because the total area of pencil pine communities has not as yet been calculated.

The old and the new, near Shadow Lake, Lake St Clair.
Photo by Barry Batchelor

Construction of a Visitor Centre, accommodation cabins, car parks, workshops and other facilities at Cynthia Bay (Lake St Clair) led to a reduction in the integrity of the woodland–scrub mosaic associated with the glacial moraines. Construction of huts and toilet facilities elsewhere in the Cradle Mountain–Lake St Clair National Park also had conservation impacts on eucalypt woodlands; however the impacts only affected a very minor component of the vegetation.

Rehabilitation of areas that had in former times been cleared in preparation for the commencement of the Gordon below Franklin dam (e.g. Warner's landing) and planned logging roads that were subsequently included within the 1989 extensions to the World Heritage Area increased the integrity of forest ecosystems within the TWWHA.

The area of eucalypt forest reserved adjacent to the TWWHA has been increased as a result of proclamation of reserves under the Regional Forest Agreement.

BUTTONGRASS MOORLAND, SCRUB AND OTHER LOWLAND HEATH COMMUNITIES

Buttongrass moorland and scrub are fire-adapted communities that occupy about 31% (439,515ha) of the TWWHA. Issues surrounding fire management in these communities (including fire frequency, fire intensity, manageability and impacts on biodiversity) pose major challenges and uncertainties for management.

Based on aerial photograph interpretation, it is estimated that as at 1999, more than half of the buttongrass moorland and scrub vegetation has remained unburned for more than 65 years. During the 1992–1999 period, only about 900ha (0.16%) of moorland within the TWWHA was burnt.

The current relative homogeneity in ages and fire frequencies suggests that the moorland of the TWWHA is not at its peak in potential biodiversity. Research is in progress to determine the links between structural and floristic changes in the vegetation associated with fire frequency and the suitability of the vegetation to support various fauna species. It is known for example that small mammal species diversity and abundance takes at least 5 years to recover following fire. Preliminary findings of invertebrate surveys suggest that the minimum interval between controlled burns for the protection of invertebrate biodiversity should be five years and the optimum interval between burns appears to be about 20 years. However, burning of moorlands has also been linked with the degradation of other conservation values such as the loss of massive volumes of organic peat soils over very large areas (see Section 5.2.1 'Condition of geodiversity').

Track and campsite hardening and revegetation of degraded sites, quarries, tracks and roadsides have improved the integrity of some moorland areas, e.g. at Adamsfield and the Jane River mine site.

The introduced root rot fungus *Phytophthora cinnamomi* continues to be a serious threat to the integrity of buttongrass moorlands (see Section 4.7 'Plant diseases and dieback').

COASTAL COMMUNITIES

The coastline of the TWWHA is about 630km in length and free of any developments other than a walking track and small campsites. The vegetation of this coastal region includes a range of habitat types including extensive sheltered estuaries and harbours, exposed sandy beaches, rocky coasts and cliffs, reefs and offshore islands. Much of the coastline has remained unburned for substantial periods and coastal rainforest occurs down to the high tide mark in a number of locations. The non-forest coastal vegetation occupies about 5,504ha or only 0.5% of the TWWHA.

In recent history, the coastal vegetation of the TWWHA has had only limited disturbance by people. Walking and camping have caused localised degradation and erosion at campsites and along walking tracks. Over the 1992–1999 period, these impacts have been mitigated to some extent by campsite and track hardening and/or track re-routing and rehabilitation.

There were no fires reported for coastal communities during the 1992–1999 period. The introduction of Fuel Stove Only Areas throughout the TWWHA reduced the risk of fires in this fire sensitive vegetation. However, the risk of deliberate and accidental fires associated with use of coastal areas by fishers and walkers remains relatively high. See Section 4.6 'Wildfires'.

The recent invasion of the weeds marram grass (*Ammophila arenaria*) and sea spurge (*Euphorbia paralias*) along the coastline of the TWWHA and adjacent areas poses an extremely serious threat to the integrity of coastal ecosystems. See Section 4.8 'Weeds and other introduced plants'.

Other emerging threats to the community include increasing access along coastal areas by motorised vehicles (all terrain vehicles or quad bikes).

WETLANDS, AQUATIC AND RIPARIAN ECOSYSTEMS

The diverse wetland and aquatic ecosystems of the TWWHA are of great conservation significance. They include marine harbours, estuaries, coastal lagoons, dark tannin-stained lakes, rivers, and creeks as well as clear-water dolerite lakes, rivers and creeks and other wetland types. Together they support a rich, diverse and in some cases unique biota.

Mostly these systems are in pristine condition and overall there are remarkably few introduced species. The existence of trout-free rivers and lakes in the TWWHA is of high conservation value as trout are a major threat to the integrity of natural aquatic ecosystems.

Pre-existing impacts on the aquatic and riparian communities of the TWWHA include the Lake Pedder dam (built in 1972) which caused a change in the overall ecology of the lake (including the introduction of brown trout and climbing galaxias). These changes were associated with the near extinction of the Pedder galaxias fish (*Galaxias pedderensis*). Recent management efforts to conserve the Pedder galaxias are yielding positive results (see Section 5.7.3 'Endangered species: Pedder galaxias fish (*Galaxias pedderensis*)'.

Impacts on aquatic and riparian[44] communities over the 1992–1999 period included:

- The number of trout-free rivers and lakes in the TWWHA declined as a result of illegal introductions of trout to some areas particularly lakes in the western lakes region (including Lake Fox, Frozen Lagoon, Last Lagoon, Jacks Lagoon, Lake Leonis, Lake McCoy, Lake Bill, Lake Ayr and a number of smaller unnamed waters in the Blue Peaks area and in the Wadleys–Zig Zag areas). There were also unconfirmed reports of illegal stocking of trout into Lake Myrtle and Lake Louisa. (See Section 2.5.2 under the subheading 'Unlawful stocking of trout into trout-free lakes and rivers').
- The ecological integrity of the meromictic lakes adjacent to the lower Gordon River (which supported a unique and diverse microscopic biota) has probably been degraded or lost as a result of hydrological changes associated with the regulation of river flows by hydroelectric scheme operations. (See Section 4.14 'Regulation of river flows by hydroelectric power generating operations'.)
- Erosion of riverbank and lakeshore vegetation continued in some areas (e.g. along the middle Gordon River, and at Lake St Clair[45]) as a result of regulation of water levels and/or flows associated with hydroelectric scheme operations; and in other areas (e.g. the lower Gordon River) as a result of commercial cruise boat operations (see Section 4.10.2 'Case study—Riverbank erosion on the lower Gordon River').

In addition, although the translocation of the Pedder galaxias fish into Lake Oberon in Western Arthurs appears likely to have saved the species from imminent extinction, its translocation meant that a relatively pristine lake that did not naturally contain fish has now been changed.

MARINE COMMUNITIES

There has only been limited study of the marine flora and fauna of the TWWHA to date. During the 1992–1999 period, a previously unknown and significant community of marine invertebrates was discovered in Bathurst Channel (Edgar 1989, Barrett et al 1998, Last & Edgar 1994). This community is vulnerable to disturbance from boat anchors, ship motors, and divers, as well as to increased nutrient levels from sewage disposal and the establishment of introduced marine species.

The vast natural coastlines of southwest Tasmania support some of the least disturbed coastal ecosystems in the world.
Photo by PWS Tracks Team

44 'Riparian' means of or on a riverbank.

45 Negotiations with the HydroElectric Corporation have resulted in changes to the management of water levels in Lake St Clair (which have been incorporated in the 1999 TWWHA management plan) and these are expected to result in improved conservation of this vegetation in future.

Condition of plant species

The diversity and conservation status of plant species in Tasmania and the TWWHA is summarised in the table below. The terminology used in this table follows that specified in the *Threatened Species Protection Act 1995* and the *Environmental Protection and Biodiversity Conservation Act 1999*.

Diversity and conservation status of plant species in Tasmania and the Tasmanian Wilderness World Heritage Area[46]

	Native Species		Naturalised Exotic Species		Endemic Species		Threatened Species					
							rare		vulnerable		endangered (extinct species)	
VASCULAR PLANTS	Tas	WHA	Tas	WHA	Tas	WHA	Tas	WHA	Tas	WHA	Tas	WHA
Orchidaceae	197	56	0	0	62	10	16	2	3	0	45 (2)	0
Eucalyptus	30	18	0	0	16	10	5	1	0	0	2	0
Monocoty-ledonae (excl. orchids)	614	291	211	35	134	61	80	25	3	0	5 (3)	1
Dicotyledonae (excl. eucalypts)	1049	571	508	93	299	193	161	46	48	4	42 (17)	3
Pteridophyta	101	73	1	0	6	5	10	3	6	0	1 (1)	0
Gymnospermae	10	8	1	1	8	7	0	0	2	1	0	0
Total Vascular	1775	943	724	129	447	266	272	77	62	4	95 (23)	4
NON-VASCULAR PLANTS												
Mosses	382	225	3	1	35	9	34	23	17	12	63 (18)	11 (2)
Liverworts	323	255	1	0	17	14	47	32	11	11	38 (15)	14 (3)
Lichens	655	NA*	NA	NA	NA	NA	7	1	4	NA	4 (1)	NA
Marine Macro-Green Algae	67	13	1	0	0	0	0	0	0	0	0	0
Marine Macro Brown Algae	144	27	1	0	2	1	1	0	0	0	0	0
Marine Macro Red Algae	422	50	0	0	12	0	0	0	0	0	0	0

*NA= not available

Sources:
VASCULAR PLANTS: data for the number of native and introduced vascular taxa have been derived from Buchanan (1999). The number of recognised plant species within the World Heritage Area has been obtained from Kirkpatrick *et al.* (1991), in conjunction with data from the Tasmanian Herbarium. Threatened Species data have been derived from schedules of the *Threatened Species Protection Act 1995*.
NON-VASCULAR PLANTS: data for liverworts and mosses have been derived from the preliminary conservation assessment provided in Moscal et al. (1996). However, species recognised as vulnerable, endangered and critically endangered by the authors have been listed in this document under the categories of rare, vulnerable and endangered respectively (note that no bryophyte species are currently listed under the *Threatened Species Protection Act 1995*). Data for the number of native and introduced taxa for bryophytes within Tasmania and within the World Heritage Area have been derived from Moscal et al. (1996). Tasmanian lichen numbers were taken from Kantvilas (1989) and information regarding the Tasmanian algae has been derived from Sanderson & Balmer (unpublished, DPIWE files). Data on TWWHA marine macroalgae were obtained from Barrett et al. (1998), Last & Edgar (1994) and Edgar (1984).

46 As at June 2003

RARE AND THREATENED PLANT SPECIES

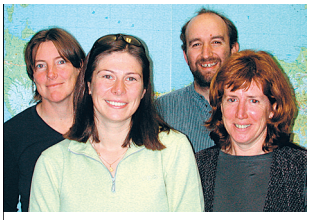
The reservation and conservation status of Tasmanian vascular plants was estimated in 1991. At that time, threatened species numbers were considered to be:

- 32 extinct plant species;
- 29 endangered species;
- 61 vulnerable species; and
- 103 rare species with restricted distributions, 316 rare species with only a few populations although widely dispersed and 6 rare species with widely dispersed but small populations.

In all, 541 species were considered rare or threatened in Tasmania. Of these species, 153 were known to occur within the TWWHA.

Since 1991, an increase in knowledge of plant numbers, plant distribution and taxonomy has reduced those taxa thought to be rare or threatened. In 1995, the Tasmanian *Threatened Species Protection Act* was introduced and the first schedules contained a total of 451 vascular and 9 non-vascular plant species.

There are 452 vascular and 18 non-vascular taxa currently listed under the *Threatened Species Protection Act 1995*, of which just 85 are thought to occur within the TWWHA. In the period of 1995–2001, 4 species have been added to the flora schedules of the *Threatened Species Protection Act 1995*: 2 species listed as endangered, one as vulnerable and one rare. It is important to note that some Tasmanian species listed on the State Act are also covered by Commonwealth legislation under the *Environmental Protection and Biodiversity Conservation Act 1999*. As issues relating to threatened species are a matter of National Environmental Significance, listed Tasmanian endemic species also qualify for Commonwealth protection. Species included in this category are listed below in the relevant groupings. There are no Tasmanian non-vascular species currently listed on the *Environmental Protection and Biodiversity Conservation Act 1999* schedules.



Staff of the Flora Section (Nature Conservation Branch, DPIWE) provide professional information and advice about vegetation in the TWWHA and its management. From left to right: **Jayne Balmer** (Botanist for the southern region of the TWWHA); **David Story** (Monitoring Officer whose work has included the Vegetation Management Strategy and fire monitoring projects), **Nicki Chilcott** (Project Officer whose work has included Pine Lake dieback and experimental walker trials) and **Jennie Whinam** (Botanist for the northern region of the TWWHA).

Photo by Sophie Underwood

Conservation status[47] of vascular plant species in Tasmania and the Tasmanian Wilderness World Heritage Area listed under the *Environmental Protection and Biodiversity Conservation Act 1999*

	Tasmanian Threatened Species listed under the EPBC Act 1999					
	vulnerable		endangered		critically endangered (extinct species)	
VASCULAR PLANTS	Tas	WHA	Tas	WHA	Tas	WHA
Orchidaceae	3	1	9	0	20	0
Eucalyptus	0	0	1	0	0	0
Monocoty-ledonae (excl. orchids)	2	1	2	0	0 (1)	0
Dicotyledonae (excl. eucalypts)	10	3	15	1	12 (1)	2
Pteridophyta	1	0	1	0	0	0
Gymnospermae	0	0	0	0	0	0
Total Vascular	16	5	28	1	32 (2)	2

47 As at June 2003

A summary of rare and threatened plant species is provided in Appendix 7.

Condition of animal species

CONSERVATION STATUS OF ANIMAL SPECIES

The TWWHA plays a significant role in the conservation of Tasmania's fauna. Of Tasmania's 249 native terrestrial and freshwater species of vertebrate 75% (187 species) occur in the TWWHA (see table below). This list includes 27 species that are endemic to Tasmania. The TWWHA also encompasses small areas of marine (including estuarine) habitats such as the southeastern part of Macquarie Harbour, Port Davey–Bathurst harbour and New River Lagoon. To date, 87 species (16% of the state total) of marine vertebrates have been recorded. The distributions of seven vertebrate species are entirely restricted to the WHA (pedra branca skink, mountain skink, moss froglet, Pedder galaxias, swamp galaxias, western paragalaxias and Bathurst harbour skate). In addition a further eight species have the majority of their range within the TWWHA (broad-toothed mouse, ground parrot, southern emu-wren, Tasmanian tree frog, northern snow skink, southern snow skink and the Clarence galaxias). Many species of vertebrate are widespread within the TWWHA, including species that are rare or absent outside the TWWHA as well as species that are widespread elsewhere in Tasmania.

The TWWHA plays an important role in the conservation of a number of migratory bird species, most notably the endangered orange-bellied parrot, which breeds only in southwest Tasmania. Eucalypt forests, particularly in the central and northern parts of the TWWHA, provide important feeding areas for the endangered swift parrot on the species' annual migration to mainland Australia. Many other non-threatened birds that migrate between Tasmanian and the Australian mainland use the TWWHA for summer breeding and feeding (e.g. swamp harrier, cuckoos, striated pardalote, satin flycatcher, grey fantail, and black-faced cuckoo-shrike). The TWWHA also provides habitat for a number of birds that migrate between Tasmania and the northern hemisphere (e.g. short-tailed shearwater, sooty shearwater, bar-tailed godwit, red knot, red-necked stint)[48].

Michael Driessen (Zoologist for the TWWHA) has worked for the managing agency since 1988 in various positions involved with fauna research and management e.g. dealing with wallaby, bettong and bandicoot management. Key issues in the TWWHA that Mike has been involved with include the effects of fire on fauna, introduced animal management, threatened species management, and improving knowledge and management of invertebrates.

Photo by Sophie Underwood

Knowledge of the invertebrate fauna of the TWWHA is considerably less than vertebrate fauna and any list of species will be both incomplete and subject to regular change. Nevertheless recent inventories reveal that a very high percentage of invertebrate fauna that occur in the TWWHA are also Tasmanian endemics. Freshwater invertebrates with a high level of Tasmanian endemism in the TWWHA include the Anaspidacea (100% endemicity), Decapoda (100%), Cladocera (100%), Isopoda (56%), Amphipoda (95%), Ephemeroptera (67%), Plecoptera (90%) and Trichoptera (70%). Terrestrial or terrestrial and freshwater taxa with a high level of Tasmanian endemism in the TWWHA include the Oligochaeta (97%), Gastropoda (79%), Diplopoda (100%), Opiliones (97%), Pseudoscorpionida (50%), Orthoptera (65%), Mecoptera (100%) and Thysanoptera (71%)

A high proportion of these endemic invertebrate species have the majority or entirety of their range located within the TWWHA (e.g. Oligochaeta 32%; Gastropoda, 42%; Amphipoda, 37%; Isopoda 36%; Anaspidacea, 80%; Decapoda, 73%). The percentages for high Tasmanian endemicity and species restricted to the TWWHA (or western Tasmania) may be significantly higher than the above figures because the current lists of formally described species are likely to be biased in favour of more common and better surveyed species with an eastern Tasmanian and/or Australian element to their distribution.

The TWWHA provides important habitat for over 30 species of vertebrate and invertebrate fauna listed on the schedules of the Tasmanian *Threatened Species Protection Act 1995*. Most of these species are well protected within the TWWHA and are threatened by various activities outside the TWWHA. For example the orange-bellied parrot breeds only in southwest Tasmania during summer and migrates to mainland Australia where its winter habitat is under threat from land clearance and other disturbance. Many species in the TWWHA have naturally very restricted distribution that make them vulnerable to random events (e.g. Hickmans *Allanaspides*, pedra branca skink, and cave species).

48 These species are listed under CAMBA and JAMBA (the China/Australia and Japan/Australia migratory bird agreements respectively) in the *EPBC Act 1999*.

Conservation status of animal species in Tasmania and the Tasmanian Wilderness World Heritage Area[49]

Taxon	Total Number of Species		Rare Species		Vulnerable Species		Endangered Species	
	in Tasmania	in WHA	in Tasmania	in WHA	in Tasmania	in WHA	in Tasmania	in WHA
Terrestrial & fresh-water mammals	33	30	1	1	0	0	1	0
Marine mammals	41	4	1	1	1	0	5	1
Terrestrial & fresh-water birds	159	120	2	2	1	0	11	7
Marine birds	32	15	3	1	6	1	7	2
Terrestrial & fresh-water reptiles	21	14	1	0	1	0	2	1
Marine reptiles	6	0	0	0	3	0	1	0
Amphibians	11	7	1	0	1	0	0	0
Freshwater fish	25	16	4	1	3	1	5	2
Marine fish	487	68	0	0	1	0	2	1
Terrestrial & fresh-water vertebrates	249	187	9	4	6	1	19	10
Marine vertebrates (excluding fish)	560	87	4	2	11	1	15	4
Terrestrial & fresh-water invertebrates	?	?	89	12	13	1	15	3

49 As at June 2003

RARE AND THREATENED ANIMAL SPECIES

In 1995 the Tasmanian *Threatened Species Protection Act* was proclaimed. This list contained 159 rare and threatened fauna (44 vertebrates and 110 invertebrates) of which 25 occurred in the TWWHA (12 vertebrates and 13 invertebrates).

By 1999 there were several changes to the list as a result of new knowledge or administrative changes. Apart from one species (the swift parrot, whose conservation status declined), none of the changes were due to a real change in the status of species occurring in the TWWHA. The conservation status of the swift parrot declined from Vulnerable to Endangered due to a decline in abundance in areas outside the TWWHA.

Two native fish species (swamp galaxias and western paragalaxias) were added to list as a result of their naturally restricted distribution and ongoing concerns about the impacts of introduced fish. Several species were either de-listed (Pencil Pine Moth) or had conservation status changed from vulnerable to rare (blind cave beetle, Mole Creek Cave Beetle) as a result of surveys organised by the managing agency that showed that they were more common than previously known.

The status of several species was changed to 'endangered' from 'rare' (grey goshawk) or 'vulnerable' (wedge-tailed eagle, soft-plumaged petrel) due to changes in listing criteria. Three rare and threatened species (Mole Creek cave harvestman, pseudoscorpion and beetle) were found to occur in the TWWHA in 1999 as a result of surveys organised by the managing agency. A comprehensive survey for the Lake Pedder earthworm in 1999 failed to find any specimens and it is highly likely that this species is now extinct.

At the time of writing (August 2003), there are 39 rare or threatened fauna (23 vertebrates and 16 invertebrates) known to occur within the World Heritage Area. A summary of rare and threatened animal species in the TWWHA is provided in Appendix 8.

Genetic diversity and biogeographic integrity

The flora of the TWWHA includes strong representation of Gondwanan (or Antarctic) elements, particularly in the rainforest and alpine communities. The sclerophyllous flora of Australia, including the TWWHA, is distinct at least at a generic level. The sclerophyllous flora has a high representation of species that have evolved in Australia—the autochthonous element. The autochthonous element evolved a sclerophyllous morphology in response to poor soil fertility, particularly low phosphorous concentrations.

Nine of the 20 eucalypt species that occur in the TWWHA are endemic, and two others are represented by endemic varieties, and are therefore rare on an international scale. Geographically isolated populations of *Eucalyptus globulus* have genetic traits useful to the forest industry. *E. gunnii* and *E. archeri* have evolved with significant frost tolerance.

The yellow gums (*E. vernicosa* group) provide the most dramatic example of response to evolutionary processes. The group varies clinally from the tall forest tree form (*E. johnstonii*) through *E. subcrenulata* to the stunted alpine shrub *E. vernicosa*. Associated with site/height changes are changes in traits such as leaf and reproductive morphology. The full continuum of this clinal variation occurs on the slopes of Mt Arrowsmith. Understanding of this group has recently increased as a result of research (see McGowan, 2000).

Considerable clinal variation is found in *E. nitida* (the most widespread eucalypt in the TWWHA) and *E. amygdalina*. Clinal intergradation occurs between the two alpine white gums, *E. archeri* and *E. gunnii*, partly as a result of introgressive hybridisation.

The fauna of the TWWHA has strong affinities to fauna of Gondwana. Examples of taxa well represented in the TWWHA that have clear Gondwanan links include the monotremes, parrots (family Psittacidae), two frog families (Myobatrachidae and Hylidae), the freshwater fish family (Galaxiidae), cave spiders (Hickmaniidae), freshwater crustaceans (Anaspidacea, Parastacidae, Phreatoicidae) and insect groups (Plecoptera, Acrididae, Odonata, Trichoptera). In addition to Gondwanan taxa, the TWWHA supports a number of invertebrate species with distributions indicating they are relicts of more ancient fauna—Pangea relicts. Taxa include a primitive lungless mysmenid spider *Trogloneta*, the alpine Archiearine moths, a primitive lepidopteran *Sabatinca*, a recently discovered new genus and species of pseudoscorpion *Anysrius chamberlin*, and a recently discovered new species of caddisfly *Tricholeiochiton pennyae*.

In addition to such relictual taxa, much of the endemic fauna (particularly invertebrates) of the TWWHA may be neoendemics that have evolved in-situ in more recent times. For example the confinement of species to fragmented glacial refuges (such as pockets of vegetation or caves) during the last ice age, as well as post-glacial expansion and speciation with the retreat of icesheets may have contributed to a large number of neoendemics characteristic of western Tasmania e.g. freshwater fish *Galaxias*, Opliones *Hickmanoxyomma*, and Orthoptera *Micropathus, Russalpia*.

Ecological, evolutionary and earth processes

ECOLOGICAL SUCCESSION

Over the 1992–1999 period, the age of vegetation increased across most of the TWWHA as a consequence of there being very few fires in the area during this period.

For most ecosystem types or for much of the area this is not considered to be a problem—in fact, it is a positive factor as much of the area has increased in conservation value as a consequence. There is however a problem with lowland buttongrass moorlands all moving into age classes well in excess of 20 years of age because it becomes difficult to maintain a mosaic of vegetation ages within this ecosystem. Build-up of fuel loads in old-growth buttongrass moorlands is also considered to create a significant risk for 'landscape scale' fires (see Section 4.6 'Wildfires').

In addition, for scrub boundaries to expand into buttongrass moorland, occasional fire events may be necessary in order to enable the release of seed from the scrub species

not present in moorlands. In order for scrub species to germinate in the moorland, the moorlands need to have been burnt to expose sufficient amounts of bare ground.

MEROMIXIS

The rare hydrological phenomenon of meromixis has been lost or reduced in all the lakes adjacent to the lower Gordon River due to hydrological modification associated with hydro power generation operations (see Section 4.14 'Regulation of river flows by hydro-electric power generating operations').

COAST DUNE PROCESSES

Natural coastal dune processes have been altered where marram grass (an introduced species) has become established in the TWWHA. See Section 4.8.2 'Case study—Eradication program for marram grass (*Ammophila arenaria*)'

ALKALINE PANS

The unusual occurrence of dolomite and limestone outcrops within the highly acidic buttongrass peatlands has allowed the development of specialised plant communities on these 'alkaline pans'. A number of species obligate to these alkaline conditions such as *Isoetes* 'Maxwell valley' sp. nova and *Milligania johnstonii*, *Liparophyllum gunnii* and *Baumea juncea* occur in these pans but not elsewhere in the buttongrass moorlands. The maintenance of the alkaline conditions is still a matter of conjecture and may relate to the removal of acid peats by fire. The range in pH conditions across the pan varies from 4.0 at the pan edge through to 8.0 over a distance of less than one metre. The species are sorted into communities within these pans along this pH gradient.

5.3 Wilderness quality

Key Desired Outcome addressed in this section:

KDO 4.2: Maintenance or enhancement of wilderness quality.

'Wilderness quality' is concisely defined as the extent to which a location is remote from and undisturbed by the influence of modern technological society[50].

The two essential attributes of wilderness are remoteness and naturalness. 'Remoteness' refers to remoteness from settlement (remoteness from places of permanent occupation) and remoteness from access (remoteness from established access routes). 'Naturalness' refers to apparent naturalness (the degree to which the landscape is free from the presence of permanent structures associated with modern technological society); and biophysical naturalness (the degree to which the natural environment is free from biophysical disturbance caused by the influence of modern technological society). Areas of high wilderness quality may display evidence of previous occupation and influence by Aboriginal people, and may also contain limited evidence of previous activities of colonial societies.

Studies conducted during the Comprehensive Forest Assessment–Regional Forest Agreement process by the Australian Heritage Commission reconfirmed the extremely high wilderness quality of most of the TWWHA and the national and international significance of the extent of those lands. The map of wilderness quality in Tasmania in Figure 17 was generated from data compiled by the Australian Heritage Commission and available from the *Australian Land Disturbance Database* at <http://www.heritage.gov.au/anlr/code/ald.html>. Figure 17 clearly reveals the extent and quality of wilderness protected by the TWWHA.

50 Department of the Environment and Heritage. Australian Land Disturbance (National Wilderness Inventory) http://www.heritage.gov.au/anlr/code/ald.html

Most of the impacts on wilderness quality and viewfields in the TWWHA exist as a result of earlier (pre-existing) developments such as roads (primarily the Lyell Highway, Lake Highway, Gordon River Road and Scotts Peak Road) and hydroelectric developments notably in the Strathgordon–Scotts Peak area, Mt Arrowsmith, Lake St Clair, Lake Augusta

and Lake MacKenzie areas. However, these developments were already present at the time of inscription of the World Heritage Area and their impacts on wilderness quality have not changed in recent years.

Over the 1992–1999 period, there was no significant change in wilderness quality in the TWWHA, although there were some particular areas where wilderness quality either increased or decreased as outlined below.

Some restoration of wilderness quality occurred in the TWWHA over the 1992–1999 period as a result of the closure and rehabilitation of several 4WD tracks that impacted on wilderness quality (e.g. Raglan Range track, Jane River track and some minor tracks in the Little Fisher River area) and the removal of several redundant huts and shelters. However, most other rehabilitation programs undertaken by the managing agency addressed degraded areas adjacent to pre-existing and ongoing impacts (such as roads and tracks) so although these programs improved local aesthetic and environmental quality, they had minimal impact on wilderness quality.

The anticipated major enhancement of wilderness quality that was to have been achieved through the closure and rehabilitation of the Mt McCall 4WD Track as prescribed by the 1992 management plan did not proceed. This change in management action was formally approved through amendment of the 1992 management plan (Parks and Wildlife Service, 1997).

Some minor losses of wilderness quality occurred during the 1992–1999 period as the result of the development of new walking tracks (including several instances of unauthorised cutting and marking of new tracks into remote and relatively pristine areas). In addition, a substantial amount of 'track hardening' (e.g. construction of boardwalk, drains and steps) was undertaken on major walking tracks in remote areas. While the existence of these constructed tracks reduced wilderness quality compared to having no track at all, constructed tracks avoid the development of multiple degraded braided tracks that would otherwise result from the increasing level of use of these tracks. Nonetheless, some walkers find the 'unnatural' track construction a greater impact on the quality of their wilderness recreational experience than 'unconstructed impacts' such as braiding and erosion.

Other minor losses in wilderness quality over the 1992–1999 period were associated with viewfield intrusions of the new Visitor Centre at Lake St Clair (which is visible from surrounding mountains and from some distance up the lake), and the new Kia Ora hut on the Overland Track.

Activities on adjacent lands outside the TWWHA (including logging operations, the construction of forestry roads and construction developments) are likely to have resulted in some losses of wilderness quality within the TWWHA through the disturbance of viewfields from within the area, e.g. adjacent to Hartz Mountains National Park and Southwest National Park in the Cockle/Hastings/Hartz areas.

Measured changes in wilderness quality over the 1992–1999 period cannot reliably be derived from the existing wilderness quality data for the area due to differences in methodologies between studies. The Australian Standard methodology for wilderness quantification (the National Wilderness Inventory or NWI) is of limited managerial use for the TWWHA as its sensitivity is insufficient to detect variations within what is generally very high wilderness quality. In particular it does not give different weightings to the impacts of different types of walking tracks and routes or take into account the effects on viewfields of terrain and vegetation (Donohue, 1998). An 'enhanced NWI methodology' is needed in order to enable relatively minor changes in wilderness quality to be detected[51].

Periodic re-survey and mapping of wilderness quality is required to enable the net changes in wilderness quality of the TWWHA to be accurately determined.

51 The development of an enhanced methodology for the quantification of wilderness is a prescribed action of the 1999 TWWHA management plan.

The Tasmanian Wilderness—magnificent and inspiring. The vast majority of the Tasmanian Wilderness World Heritage Area is of extremely high wilderness quality.
Photo © PWS

Even a simple walking track can impact on the wilderness quality of an otherwise natural vista. South West Cape circuit track.
Photo by Stuart Graham

Undisturbed natural river systems are one of the outstanding values that contributed to southwest Tasmania being listed as a World Heritage Area. New River Lagoon, Prion Beach on the south coast.
Photo © PWS

5.4 Environmental quality

Key Desired Outcome addressed in this section:

KDO 4.3: Maintenance or enhancement of environmental quality.

5.4.1 Water quality

The water quality of surface water within the TWWHA is generally high. However, a lack of adequate sanitation or sewage treatment in some areas is associated with local water quality problems and other pollution.

A 1995/96 survey of surface water quality at 31 sites in 3 key locations considered to be vulnerable to impacts associated with high visitor use and camping[52] showed that all of the surveyed sites complied with the national water quality guidelines for primary and secondary contact (Davies & Driessen 1997, ANZECC 1992). However none of the surveyed sites complied with the national guidelines for drinking water (NWQMS, 1996) due to the presence of faecal coliforms from native wildlife and possibly humans. All sites were of high water quality for natural surface waters with respect to nutrients, with the very low nutrient levels reflecting the largely pristine nature of the water catchments in the TWWHA. No impacts on water quality from parks infrastructure were detected at the sites tested.

Barry Bachelor (Ranger, Lake St Clair) collecting water samples as part of the ongoing water quality monitoring program to investigate the impacts of park infrastructure and visitors on water quality in the TWWHA.

Photo by Mike Driessen

In 1999, water quality was monitored at three sites along the Overland Track–Pelion Plains, Kia-Ora and Waterfall Valley (Davies & Driessen, 1999). The results indicated low to occasionally high levels of faecal bacterial contamination with several sites failing to meet the national guidelines for primary recreation contact. The only sites with greater bacterial contamination compared with upstream controls were at the downstream end of Douglas Creek, Pelion Plains. Subsequent sampling suggested that the contamination was probably of animal (rather than human) origin. Results of single spot samples indicated that visitor facilities were not increasing overall nutrient levels in receiving streams although public toilet outflows at Kia Ora and Waterfall Valley were associated with raised ammonia levels downstream. All streams were characterised by high diversities and abundances of macroinvertebrates.

Giardia, a water-borne parasite that causes gastroenteritis in humans, was confirmed to be distributed widely across Tasmania, including some remote areas of the TWWHA (Kettlewell, 1995).

The environmental and aesthetic quality of campsites along the Franklin River improved as a result of changes in the operations of commercial rafting tours, including commencing taking out all their clients' waste (including faecal waste).

In western Tasmania, the legacy of a century of environmentally insensitive copper mining operations at the Mt Lyell mine (near Queenstown) continues to degrade water quality in Macquarie Harbour through the discharge of the heavily polluted King and Queen Rivers[53] which carry acid drainage and heavy loads of toxic metals (including copper, zinc, and cadmium). Research undertaken under the Mt Lyell Remediation Research and Demonstration Program and the Macquarie Harbour–King River Study detected significant heavy metal concentrations in the water and sediments of these waterways. The environmental quality of the southern portion of Macquarie Harbour, which lies within the TWWHA, is described below.

The waters of Macquarie Harbour within the TWWHA resemble a 'copper-sandwich' with high copper-bearing water overlain by clean Gordon River water and underlain by clean seawater. Copper levels of greater than 50mg/L have been documented in the water within the TWWHA and are commonly greater than 20mg/L (Koehnken 1996, DPIWE monitoring data 1993–2003). ANZECC guidelines for the protection of aquatic ecosystems for marine environments indicate levels of 1–2mg/L. Copper concentrations within the sediments of much of the TWWHA portion of the harbour exceed 1,000mg/kg and high metal concentrations penetrate the sediments to a depth of at least 15cm

52 Sampling sites were at Lake St Clair (11 sites), Walls of Jerusalem (9 sites) and Melaleuca (11 sites).

53 These river systems are outside the TWWHA.

(Koehnken, 1996). The ANZECC Interim Guidelines for Sediment Quality indicate levels of 65mg/kg for low risk and 270 mg/kg for high risk. The concentrations of heavy metals in Macquarie Harbour sediments are consistent with the levels indicated for classification of the area as a 'contaminated site' under internationally recognised standards.

Biological surveys of fish and macroinvertebrates found that the diversity and number of organisms in Macquarie Harbour were lower than expected compared with other embayments in southeastern Australia, and that lower diversity was associated with areas where the underlying sediments contained very high copper levels (Talman et al 1996).

There were no reported environmental accidents or other significant polluting events in the TWWHA over the 1992–1999 period.

Lyell Highway rehabilitation, Mt Arrowsmith.

Locally sourced native plants being propagated in preparation for the rehabilitation of the former lakeside carpark at Cynthia Bay, Lake St Clair (October 1995).

Photos by Barry Batchelor

5.4.2 Air quality

The air quality of the TWWHA is normally amongst the cleanest in the world. The area continually receives cold, fresh, clean westerly winds that have travelled across thousands of kilometres of open ocean. Nonetheless, large and/or hot forest fires can cause significant episodes of widespread smoke pollution across the state.

Also of potential concern for air quality at a local scale is the increase in use of wood heaters in the accommodation cabins in and adjacent to the TWWHA, especially in those areas where accommodation facilities are expanding e.g. at Pencil Pine (near Cradle Valley).

On a very local scale, odours associated with inadequate toilets and sewage effluent can at times degrade visitors' quality of experience.

5.5 Landscape quality

Key Desired Outcome addressed in this section:

KDO 4.4: Maintenance or enhancement of landscape quality.

There were no major new impacts on the landscape and scenic qualities of the TWWHA over the 1992–1999 period, and active rehabilitation programs at a range of degraded sites achieved considerable local improvements in landscape quality and the aesthetics of viewfields.

Most degraded sites within the TWWHA are the legacy of earlier developments in the area that were undertaken prior to its World Heritage listing.

Degraded sites where rehabilitation works were undertaken during the 1992–1999 period included major roadside scars, gravel scrapes, quarries and former mine sites, old logging roads and exploration tracks, extensive 4WD tracks and degraded walking tracks throughout the TWWHA. Figure 18 indicates the location and nature of physically degraded sites in the TWWHA and where rehabilitation works have been undertaken. Rehabilitation works generally included spreading local topsoil, re-contouring, drainage works, fertilising, planting seedlings, direct seeding, laying slash and jute. Subsequent revegetation of these sites—which is often a slow process—was regularly monitored and follow-up treatments undertaken as necessary.

Some of the larger sites addressed over the 1992–1999 period included: Ida Bay limestone quarry (for details, see Section 5.7.1 'Karst system at Lune River'), the Joyce River, Raglan Range and Sawback Range tracks, roadside quarries and scrapes along Lyell Highway, Lake Augusta, Scotts Peak, Gordon River and Mueller Roads and Mt McCall track roadsides, Keogh's Pimple fire tower track (Hartz Mountain National Park), and extensive work on the walking track network throughout the TWWHA. Scotts Peak airstrip (on HEC vested land) was closed and rehabilitation was commenced by Hydro Tasmania in 1998. Old quarries along the Lyell Highway underwent extensive stabilisation and rehabilitation work, resulting in the protection of important periglacial slope deposits. High voltage power lines

Jute and slash work are used to stabilise the degraded Lake Ada lunette, Central Plateau.

Photo by Michael Comfort

Michael Comfort (Rehabilitation Officer, Natural Areas) discussing with members of the World Heritage Area Consultative Committee recent rehabilitation works on the Lake Ada lunette in the Central Plateau.

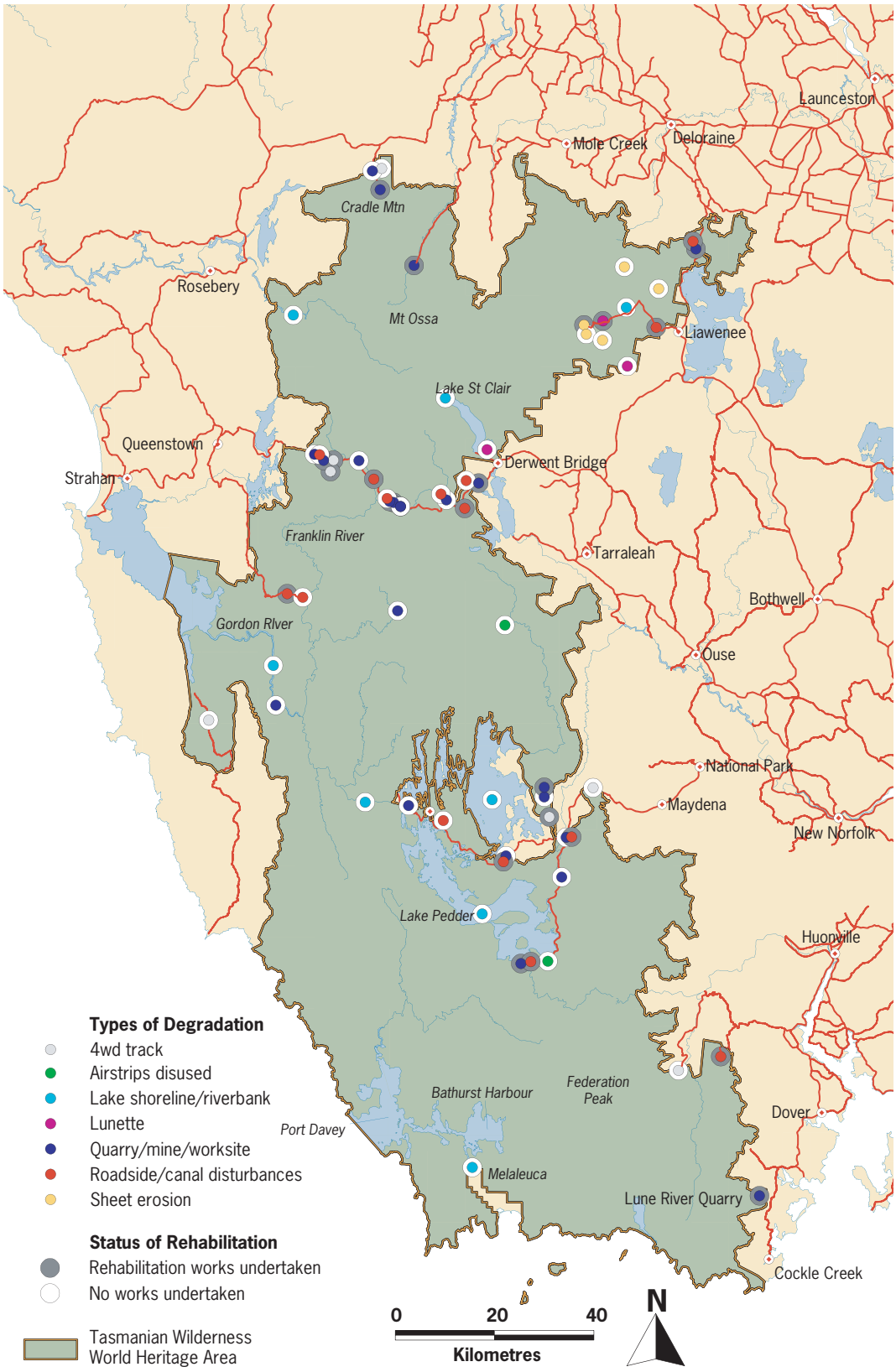
Photo by Nick Sawyer

Figure 18

Physically degraded sites and rehabilitation works in the TWWHA

Most physically degraded sites in the TWWHA are the legacy of developments in the area that occurred prior to World Heritage listing. Active rehabilitation programs have resulted in considerable local improvements in landscape quality and aesthetics, for example addressing roadside scars, former quarries and mine sites, old logging roads, 4WD tracks and extensive degraded walking tracks throughout the TWWHA. Note that this map does not show walking tracks, campsites, historic sites or sites affected by hydroelectric power generation schemes, fire or Phytophthora.

Source: Mike Comfort, Resource Management and Conservation Branch, DPIWE



between Butler's Gorge and Queenstown (which were redundant to needs) were removed and some towers visible from the Lyell Highway were dismantled.

Nationally significant lunette[54] landforms adjacent to alpine lakes on the Central Plateau were a focus of rehabilitation effort to address serious erosion on dune fronts associated with a variety of pressures including grazing, fire, trampling and lake level modifications. The rehabilitation work is expected to prevent or minimise further erosion of these features.

In addition to the above landscape rehabilitation programs, consideration of landscape quality and related issues was an important element in the development of all site plans for Visitor Services Zones and Sites for the TWWHA. In particular, landscape issues were studied extensively during the preparation of the site plan for Pump House Point (Lake St Clair), which included a proposed development for a tourist accommodation lodge. This development did not proceed[55].

There was some minor visual impact associated with track and campsite stabilisation works e.g. campsite platforms at Lake Cygnus.

There still remain a number of degraded areas within the TWWHA that require rehabilitation. The most notable of these are the extensive areas of sheet erosion on the Central Plateau (see Figure 16).

54 Lunettes are dunes bordering a lake.

55 However, in 2003, a new development is being considered.

5.6 Condition of Aboriginal and historic heritage

Key Desired Outcome addressed in this section:

KDO 4.5: Protection and conservation of historic and Aboriginal heritage (in partnership with the Aboriginal community).

The information on the condition of Aboriginal and historic heritage presented in this section has been provided by cultural heritage specialist officers employed by the Department of Tourism, Parks, Heritage and the Arts. Note that photographic images of Aboriginal heritage have not been published in this report in accordance with the wishes of the Aboriginal community.

Outstanding Aboriginal heritage was one of the reasons that the TWWHA was listed as a World Heritage Area, and Aboriginal heritage conservation is an integral component of management for the area. The main staff who were involved with Aboriginal heritage management in the TWWHA over the 1992–1999 period are, from left to right, **Sharnie Everett**, **Angie McGowan**, **Caleb Pedder**, **Julie Gough**, **Andy Sculthorpe**, and **Greg Lehman**.
Photo by Sophie Underwood

5.6.1 Aboriginal heritage

Cultural heritage specialists within the Tasmanian Heritage Office consider that Aboriginal sites within the TWWHA generally remained in a stable condition over the 1992–1999 period, with the notable exception of midden sites along the south and west coasts where wind and wave erosion caused extensive losses. A program of midden stabilisation undertaken during the period resulted in the successful conservation of a number of large midden sites along the southwest coast (see Section 4.12 'Coastal erosion of Aboriginal heritage sites').

Nonetheless, several Aboriginal heritage sites were affected by specific disturbances including:

- Ongoing sheet erosion of the Central Plateau which caused widespread disturbance of sites;
- Visitor activities and infrastructure e.g. 4WD tracks in the Central Plateau and in the southwest, and walking tracks and camping in sensitive areas such as the South Coast Track.

In addition, the Tasmanian Aboriginal Land Council reports that monitoring of Aboriginal cave sites (in particular Kuti Kina and Wargata Mina) show evidence of excessive human activity by cavers and bushwalkers. More detailed information on the condition of these sites is recorded in internal TALC reports which are not generally available.

Staff of the managing agency with responsibilities for historic heritage conservation in the TWWHA over the 1992–1999 period included from left to right **Richard Hawson** (Building Conservation Officer), **Mike Nash** (Maritime Heritage Officer), **Michael Jones** (Shack Sites Project Archaeologist), **Jo Lyngcoln** (Building Conservation Officer) and **Angie McGowan** (Manager Special Heritage Projects).
Photo by Sophie Underwood

Disturbances to Aboriginal heritage sites in some areas were reduced or eliminated through the closure or diversion of tracks and the restriction of damaging activities.

Pre-existing losses of Aboriginal landscapes (as revealed through comparisons of current landscapes with descriptions by 19th century explorers) are now recognised as having resulted at least in part from modern fire management regimes. This recognition has prompted the initiation of research into developing Aboriginal fire management techniques that may lead to the restoration of Aboriginal heritage landscapes.

Note that in accordance with the wishes of the Aboriginal community, photographs of Aboriginal cultural heritage items or sites are not presented in this report.

5.6.2 Historic heritage

All convict remains on Sarah Island and the associated sites in Macquarie Harbour and up the Gordon River are standing ruins or archaeological sites. Over the 1992–1999 period, conservation works were undertaken at selected sites on Sarah Island and these enhanced the condition of this important site. The convict heritage on Sarah Island and associated sites was well maintained over the period, and is considered to be in a stable condition.

Conservation plans and assessments for historic huts by the managing agency helped to guide maintenance and conservation works. Priority in implementing works was given to huts that continued to provide a public recreational function.

Historic huts that continued to provide a public recreational facility were well maintained over the 1992–1999 period. Several community user groups helped to maintain or restore historic huts especially on the Central Plateau and around Macquarie Harbour. Restored huts included DuCane Hut, Raglan Range (Joyce Creek) Hut, and several huts on the Central Plateau (e.g. Allisons Hut), and around Macquarie Harbour (e.g. Reindeer Lodge).

The evocative remains of an oven at Sarah Island help visitors to recall a bygone era when Sarah Island bustled with buildings and activity, and was devoid of vegetation.
Photo by Glenys Jones

Some older and smaller huts that did not provide a public recreational facility were left unmaintained. As a result, Cox Bight Hut is in great danger of collapsing, and there has been incremental deterioration of historic sites where conservation works have not been implemented (e.g. a tree fall caused damage to ruins on Sarah Island, and there has been deterioration of sites at Settlement Point and Bramble Cove in Port Davey, and at Old Pelion).

Reconstruction of the Lake Nameless hut resulted in the loss of historic heritage fabric; however the hut is now used, valued and maintained by local community groups (see Section 2.7 'Management of controversial issues').

Other historic heritage, comprising mostly the abandoned remains of various primary production activities such as whaling, pining, mining, hunting, farming, hydro-electric generation etc and their associated settlements and infrastructure generally remained in a stable condition except where they posed a threat to public safety (e.g. the old adits at Oakleigh Creek wolfram mine were blocked.)

The Penitentiary, Sarah Island. Located in the southeast of Macquarie Harbour, Sarah Island has over 108 identified historic features dating from the early 1800's period of early convict occupation. The whole island is protected under the *Historic Cultural Heritage Act 1995*. Visitors can take a scenic harbour cruise from Strahan to Sarah Island and explore the island on foot in the company of an informative guide.
Photo by Glenys Jones

5.7 Monitored condition of significant values (including degraded values)

Key Desired Outcomes addressed in this section:

KDO 4.6: Conservation of World Heritage and other natural and cultural values of significance; no or minimal loss or degradation of identified significant natural or cultural values.

KDO 4.7: Restoration of degraded World Heritage and other natural and cultural values.

The condition of a number of significant natural values (including degraded values) was monitored over the 1992–1999 period. The detailed findings of these studies are presented in the following sections. See also Chapter 4 'Protection of the natural and cultural heritage' which includes detailed reports on monitored threats and pressures on values of the TWWHA.

5.7.1 Karst system at Lune River

ABOUT THE VALUE

The limestone karst[56] system of Ida Bay was recognised as being of international scientific significance by the Helsham Commission in 1987. The Exit Cave system and its catchment fulfilled at least two of the criteria for inclusion on the World Heritage list. The system contains over 26km of mapped passages, with dimensions exceeding 30mx30m, with blind shafts reaching up over 200m into the roof making it one of the largest caves in the southern hemisphere. It contains complex cave sediments and massive calcite and moonmilk deposits (some at least 350,000 years old) which reflect environmental changes across glacial/interglacial cycles. It also contains some of Australia's most spectacular gypsum speleothems, palaeontological deposits (including megafauna species), palaeokarst deposits of Devonian and Permian age, and a rich, highly endemic and rare terrestrial and aquatic fauna.

Environmental problems associated with the nearby Lune River limestone quarry (Bender's Quarry) were first identified in the mid-1980s but the focus narrowed in 1989 with the extension of the World Heritage Area to include the quarry area. Limestone quarrying directly impacted on karst values through removal of karst features, including palaeokarst, and indirect impacts included the re-solution of speleothems by acidified quarry drainage.

In 1991, exploration and water tracing experiments established links between the quarry and the Ida Bay karst system. Quarrying activities degraded water quality by increasing the turbidity of cave streams and increasing the sedimentation of cave passages. Quarrying was also associated with organic pollution (from oils and fuels) and other changes in the chemistry of karst waters (including changes in pH, conductivity and dissolved ion concentrations).

Quarrying was associated with a low abundance of indicator species in the passages draining the quarry, especially cave-adapted aquatic invertebrates such as *Fluvidona* sp. (an aquatic snail that is very sensitive to sedimentation of its habitat). Low abundance of *Fluviodona* sp. indicated a significant reduction in water quality and ongoing effects on cave ecosystems.

Quarrying operations at Benders Quarry ceased in 1992.

There was no baseline environmental information prior to the closure of the quarry.

OVERALL MANAGEMENT GOAL: To re-establish natural karst processes and associated ecosystems including re-establishment of natural erosion rates on quarry benches and in cave-streams, and re-establishment of vegetation cover on quarry benches.

56 The term 'karst' is used to describe a region that has underground drainage with many cavities and passages caused by the dissolution of the rock.

MANAGEMENT ACTIONS AND SIGNIFICANT EVENTS OVER THE 1992–1999 PERIOD

The following management actions and/or significant events occurred over the 1992–1999 period.

- In 1992, the impacts of the quarry were documented (see Houshold 1992 and the reference list in Houshold 1995).
- The Lune River limestone quarry was closed on the 20 August 1992 by gazettal of regulations under the *World Heritage Properties Conservation Act 1983*.
- Between 1993 and 1996, active rehabilitation work was carried out on the quarry. This included: development of a rehabilitation plan; information gaps were filled; topographical/ hydrological surveys were undertaken, soil mapping, karst mapping, and cave mapping were undertaken; dye tracing established drainage linkages; vegetation was surveyed. Drainage and bench configurations to stabilise the quarry were designed; clay was stabilised; exposed cave passages were treated; topsoil was extracted; filter systems were established; soil was spread, and seed and hand planting were undertaken over 3 years.
- Environmental monitoring programs were conducted for water quality, cave stream fauna, and rehabilitation of the quarry benches.

The Lune River limestone quarry, which was closed in 1992 because of its environmental impacts on the nearby Exit Cave limestone karst system.
Photo by Parks and Wildlife Service

The Lune River limestone quarry following machine works for rehabilitation. Note the division of the benches into separate drainage cells, each feeding a vertical cave entrance or infiltration zone. This configuration attempted to reproduce the natural karst drainage systems of the Exit Cave area that were in existence prior to quarrying.
Photo by Ian Houshold

Right: Lune River Quarry rehabilitation with soils spread on benches and cave inflow filters installed, July 1993.
Photo by Barry Batchelor

Jobskill volunteers planting seedlings as part of the rehabilitation program for the Lune River Quarry, September 1993.
Photo by Barry Batchelor

A filter bund surrounding a cave entrance exposed by quarrying. The filters were built from heavy limestone blocks, various grades of crushed limestone, geotextile filter membrane and various organic mulches such as sterile straw bales and Eucalyptus bark. These bunds prevented the ingress of bench sediments and applied topsoil to the cave system whilst vegetation was re-established.
Photo by Ian Houshold

Rehabilitated Road, Lune River Quarry.
Photo by Barry Batchelor

Lune River Quarry showing the results of the rehabilitation program, June 2001. Rehabilitation successfully stabilised the quarry benches and resulted in marked improvements in the water quality and ecology of the nearby Exit Cave area.
Photo by Ian Houshold

Results

Monitored condition indicators

Condition indicators and monitoring methodology	**Targets for condition indicators** (and how performance is assessed)	**Change in condition indicators** over the 1992–1999 period
WATER QUALITY: Water quality was monitored for three years (from August 1992 to December 1995) following cessation of quarrying. Monitoring was conducted at an 'affected site' (Eastern Passage), a control or 'natural site' (Western Passage) and the main outflow stream. 'Affected' here means the site is located in the cave stream draining the quarry and has been affected by quarry runoff, sedimentation and acidification. 'Natural' here means unaffected by quarry runoff. The site is a separate stream known not to have been affected by quarry runoff. The parameters monitored were pH, conductivity; turbidity; depth; temperature; dissolved oxygen. Water quality monitoring was continuous.	TARGET FOR WATER QUALITY: Re-establishment of natural water quality at affected sites (i.e. no significant difference in water quality between affected and natural sites). ASSESSMENT OF PERFORMANCE: Ongoing event-based water sampling.	WATER QUALITY: The affected sites originally had significantly lower pH and over double the amount of suspended sediments as the natural sites. Following closure of the quarry, there was a gradual improvement and convergence of water quality between the affected and natural sites (as reflected by suspended sediments, dissolved ions and pH). Impacts have been significantly reduced, although affected sites still reflect impact at flood peak. Analysis of similar flood peaks indicates approximately 30% improvement in some variables.
SPECIES DISTRIBUTION AND ABUNDANCE: The presence/absence of stream fauna macroinvertebrates and the abundance of the aquatic snail *Fluviodona* sp. in fixed quadrats was sampled twice yearly in 'natural' and 'affected' streams from 1993 to 1997.	TARGET FOR SPECIES DISTRIBUTION AND ABUNDANCE: Re-establishment of natural species distribution and abundance i.e. no significant difference in species distribution and abundance between affected and natural sites. ASSESSMENT OF PERFORMANCE: Cave fauna quadrat analysis.	SPECIES DISTRIBUTION AND ABUNDANCE: At closure of the quarry, affected sites had between 1/4 and 1/3 the abundance of the natural sites (Eberhard, 1995). Within one year of closure of the quarry, there was a large increase in the abundance of *Fluviodona* in the main impacted passage. By 1996, the numbers appeared to have stabilised, although the abundance of affected sites was still lower than in natural passages.
SEDIMENT STABILITY AND VEGETATION SUCCESSION IN THE QUARRY: Photo-monitoring of the quarry has been carried out annually since July 1992 to track erosion and vegetation succession in the quarry.	TARGET FOR SEDIMENT STABILITY AND VEGETATION SUCCESSION IN THE QUARRY: Re-establishment of natural erosion rates on quarry benches; and re-establishment of vegetation cover and succession on quarry benches. ASSESSMENT OF PERFORMANCE: Photo-monitoring and vegetation quadrat analysis.	SEDIMENT STABILITY AND VEGETATION SUCCESSION IN THE QUARRY: At closure of the quarry, significant amounts of clay were mobile and entering cave systems. By 1996, the quarry benches were stable and/or improving in sediment stability, and vegetation had been established on quarry benches. By 2001, significant growth of vegetation had occurred and sediment stability has further increased.

Outcomes

Cessation of quarrying combined with active rehabilitation of the Lune River quarry has led to:

- stabilisation of the former quarry and the establishment of vegetation cover on the quarry benches;
- measurable improvements in the water quality and in the abundance of indicator species in cave streams downstream of the former limestone quarry;
- improvement in the overall environmental condition of the Lune River quarry area and Ida Bay karst system.

Commentary on management performance

The following commentary has been provided by specialist staff within the Nature Conservation Branch of DPIWE.

KEY FACTORS POSITIVELY CONTRIBUTING TO MANAGEMENT PERFORMANCE:

- Closure of Benders Quarry.
- Development of new rehabilitation methods focussed on karst systems. This approach involved directing surface flows underground following filtration by various organic and inorganic media, as opposed to directing water off-site.
- Establishment of vegetation using minimal fertiliser so as to minimise the effects on cave water quality.
- Implementation and monitoring of rehabilitation.

KEY FACTORS LIMITING OR THREATENING MANAGEMENT PERFORMANCE:

- Extreme weather events (e.g. high intensity rainfall events may de-stabilise quarry faces, leading to further exposure of clay pockets to erosion processes).
- The potential still exists for mass failure (ie landslips, slumps etc) to produce ongoing high magnitude but low frequency impacts.
- Any future re-opening of the quarry.
- Wildfire and/or inappropriate operational response in the event of wildfire. Protection from wildfires is extremely important in karst areas. As well, operational responses to fire in karst areas requires a different approach from that normally used, involving less use of heavy machinery and avoiding disturbance to fragile surface solution features.

SUGGESTIONS FOR IMPROVING MANAGEMENT EFFECTIVENESS

Specialist staff provided the following suggested actions for improving management of the karst system at Lune River.

- The large-scale management activities associated with rehabilitation of the quarry are now complete. Ongoing management needs to be able to respond to major events such as mass movement. This would entail construction of further settling ponds, filtration systems etc. and revegetation of disturbed sites.
- Risks of wildfires in karst areas need to be carefully managed.
- There is an ongoing need to ensure that operational responses to wildfire in karst areas are managed appropriately to minimise impacts.
- Sediment stabilisation may be required in future.
- Ongoing visitor management through cave entry permits. The cave entry permit system restricts access to certain groups, with maximum party size and frequency. The permit system is administered by PWS District staff.

Ian Houshold (Geomorphologist, Earth Science Section, DPIWE) works on the management of karst and river systems. During the 1992–1999 period, Ian carried out research, management planning and environmental rehabilitation (where necessary) for the 60 or so karst areas of the TWWHA, including developed tourist caves.

Photo by J. Dyring

SOURCES OF INFORMATION AND COMMENT

RMC Earth Science Section, Benders Quarry rehabilitation and monitoring, Ian Houshold, Geomorphologist, Ph 6233 3868, Email: Ian.Houshold@dpiwe.tas.gov.au

5.7.2 Endangered species: orange-bellied parrot (*Neophema chrysogaster*)

About the value

The orange-bellied parrot (*Neophema chrysogaster*) is listed as an endangered species under the Tasmanian *Threatened Species Protection Act 1995* and more recently under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

The orange-bellied parrot is an obligate migratory species that breeds only in coastal southwest Tasmania and spends the winter in coastal Victoria and South Australia. It nests in hollows in eucalypt trees, which grow adjacent to buttongrass moorlands where it feeds. Their overwintering habitat is principally coastal saltmarsh; however they regularly utilise degraded pastures and native grasslands along coastal margins.

According to historical records, the orange-bellied parrot was formerly widespread and abundant. It ranged from Yorke Peninsula in South Australia to Bruny Island in Tasmania, and from Geelong, Victoria, to Sydney, NSW.

The range and abundance of the parrot has declined steadily since the 1920s. The species is no longer found in NSW and has now become a rare visitor to South Australia and some parts of Victoria and Tasmania.

The reasons for the decline in orange-bellied parrots are not clear. It is likely that fragmentation and loss of mainland wintering habitat over the last 100 years has been a major contributing factor. Another suspected cause is competition for nest sites (tree hollows) from introduced European starlings within the parrots' breeding grounds. Fire age and vegetation structure of moorlands appear to play an important role in the ecology of the parrot. Only those areas with a vegetation age less than 15 years are favoured as breeding areas. The exclusion of fire from moorlands within the TWWHA may be limiting the breeding potential of the species. Other contributory factors may include the impacts of stock grazing and human disturbance (especially in mainland Australia), and competition or predation by introduced species (eg foxes and cats in mainland Australia, and starlings in Tasmania).

Melaleuca and its surrounds has been the stronghold breeding area for orange-bellied parrots, with up to 60 breeding pairs using the area. Monitoring of the breeding population at Melaleuca began in 1979 and has been conducted annually ever since. Since 1988, 474 birds in the wild population have carried standard Australian Bird and Bat Banding Scheme metal bands.

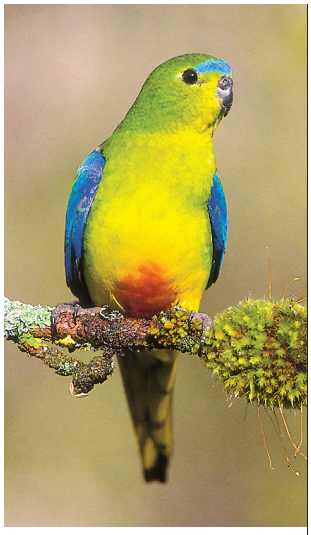
Winter monitoring of mainland populations of orange-bellied parrots has been conducted annually since the early 1980s by Birds Australia and DPIWE.

In 1981, a captive breeding program was established in Hobart, which was very successful. Since 1991, several groups of captive-bred birds have been released at Melaleuca and at Birchs Inlet, and every year a sample of 33–35 juveniles has been banded.

OVERALL MANAGEMENT GOAL: to down-list the species to Lower Risk–Conservation Dependent by 2028 in accordance with the orange-bellied parrot recovery plan.

The five year (2003) goal is to improve the conservation status of the species so that it no longer meets the IUCN criteria for critically endangered, and can be down-listed to endangered.

Five year targets associated with the above goals are to increase the size of the wild population to more than 250 mature individuals; increase the carrying capacity of critical winter habitat by 10% (although the actual area of winter habitat is not well known); and ensure that the species persists in its present range.



The total population of the endangered orange-bellied parrot is estimated to be less than 200 mature individuals.
Photo © Dave Watts

MANAGEMENT ACTIONS AND SIGNIFICANT EVENTS OVER THE 1992–1999 PERIOD

The following management actions and/or significant events occurred over the 1992–1999 management period.

- In 1992, nestboxes were erected at Melaleuca to encourage breeding and facilitate banding of nestlings by researchers for the population monitoring studies. Nest boxes offer security against predators and greater protection from the weather and these factors can potentially enhance breeding success, chick survival and overall productivity of the species.
- Monitoring of the breeding population of orange-bellied parrots at Melaleuca has been undertaken annually throughout the 1992–1999 period.
- A comprehensive survey of the summer distribution of orange-bellied parrots in the World Heritage Area was undertaken in 1999.
- A captive-breeding program was conducted at the DPIWE facilities at Taroona and at Healesville Sanctuary in Victoria. The program produced 30–50 young each year which have been used to support the re-introduction program in the TWWHA.
- Ninety-eight captive-bred birds have been released at Melaleuca and Birchs Inlet since 1999 (11–33 released per year).
- In recent years, starling numbers have been controlled at Birchs Inlet and Melaleuca to the point where competition with orange-bellied parrots for nest sites is negligible.

Results

Monitored condition indicators

Condition Indicators and monitoring methodology	**Targets for condition indicators** (and how performance is assessed)	**Change in condition indicators** over the 1992–1999 period
POPULATION SIZE: Monitoring of the breeding population of orange-bellied parrots at Melaleuca has been undertaken annually throughout the management period. This is conducted through observation of banded birds visiting feed tables at Melaleuca. A mark/recapture model is used to estimate the total population size.	TARGET FOR POPULATION SIZE: Increase the size of the wild population to more than 250 mature individuals by 2003. ASSESSMENT OF PERFORMANCE: Monitoring and population estimates are conducted by the Recovery Program Coordinator and reported to the Recovery Team. Volunteers mostly undertake the observations.	POPULATION SIZE: Population data collected since 1991 suggests that the number of orange-bellied parrots at Melaleuca has remained stable over the 1992–1999 period. Winter counts of orange-bellied parrots in Victoria and South Australia have declined since 1992. Winter monitoring has produced variable counts that are usually less reliable than the summer counts at Melaleuca. The reasons for variable and declining counts are unknown but it probably indicates that the species is using abnormal habitat, is dispersing into smaller flocks, or is moving beyond its normal range. The total population of orange-bellied parrots is estimated to have remained less than 200 mature individuals. The Melaleuca breeding population has remained stable at approximately 90–120 individuals.
RANGE OF ORANGE-BELLIED PARROTS: The range is measured by winter counts (undertaken by volunteer observations) and breeding range searches.	TARGET FOR THE RANGE OF ORANGE-BELLIED PARROTS: An important goal of the Recovery Program is to re-introduce the orange-bellied parrot to Birchs Inlet where the species was formerly known to breed. This would reduce the potential impact of stochastic (random) events on the entire population.	RANGE OF ORANGE-BELLIED PARROTS: There has been a decline in the range of orange-bellied parrots in Tasmania over the past 10 years. The distribution of the parrot in the World Heritage Area has also contracted over this period—orange-bellied parrots no longer occur naturally at Birchs Inlet and recent evidence suggests that the parrot no longer occurs at Nye Bay or Davey River. The 1999 survey confirmed that Melaleuca is the stronghold breeding area for the species. Up to 60 pairs use this area which represents 60–80% of the total wild population.
BREEDING SUCCESS OF ORANGE-BELLIED PARROTS: Breeding success is measured by monitoring nest boxes and natural nests for eggs and nestlings.	BREEDING SUCCESS OF ORANGE-BELLIED PARROTS TARGET: Increased productivity of the species.	BREEDING SUCCESS OF ORANGE-BELLIED PARROTS: Preliminary results show that in 1997/98, of a total of 41 nest boxes at Melaleuca, 14 were occupied by parrots, which produced 47 nestlings. Further data are currently being analysed.

Outcomes

- Over the last 10 years, the breeding range of the orange-bellied parrots in Tasmania has contracted to Melaleuca alone. The species no longer occurs naturally at Birchs Inlet and recent evidence suggests that it no longer occurs at Nye Bay or Davey River.
- The Melaleuca breeding population of orange-bellied parrots has remained stable at approximately 90–120 individuals over the 1992–1999 period.
- The interstate distribution of the wintering population appears to have declined over this period.
- The total population of orange-bellied parrots is estimated to have remained less than 200 mature individuals.

Mark Holdsworth (Orange-bellied Parrot Recovery Program Coordinator) removing an orange-bellied parrot nestling from a nest box in preparation for colour banding. Mark joined the Department as a Trainee Ranger in 1979 and worked in all of Tasmania's National Parks before becoming involved with the Recovery Program for the orange-bellied parrot.
Photo by Dave James

Volunteers search for orange-bellied parrot feeding and breeding sites at Birchs Inlet. Orange-bellied parrots forage on buttongrass moorlands where they feed on a variety of sedges, herbs and grasses. The fire age of buttongrass moorlands is an important feature for the orange-bellied parrots as they prefer vegetation of ages less than ten years, simply because the moorlands at this age are easier for the parrots to walk through.
Photo by M. Holdsworth

Commentary on management performance

The following commentary has been provided by specialist staff within the Nature Conservation Branch of DPIWE.

KEY FACTORS POSITIVELY CONTRIBUTING TO MANAGEMENT PERFORMANCE:

- Successful captive breeding program.
- Successful re-introduction program
- Effective use of a large volunteer workforce for monitoring programs
- Positive contribution of nest boxes to breeding success and productivity.

KEY FACTORS LIMITING OR THREATENING MANAGEMENT PERFORMANCE:

- Lack of resources and commitment to carry out habitat management burns in the Melaleuca area as recommended by the Orange-bellied Parrot Recovery Plan. These problems have more recently been overcome.
- Lack of knowledge of winter habitat requirements and management targets.
- Inability to track birds over long distances.

SUGGESTIONS FOR IMPROVING MANAGEMENT EFFECTIVENESS

Specialist staff provided the following suggested actions for improving management of orange-bellied parrots.

- Appoint a 'Recovery Coordinator' for orange-bellied parrots to facilitate recovery actions in accordance with the orange-bellied parrot recovery plan (Starks & Holdsworth, 2003) and to conduct an analysis of population viability for the orange-bellied parrot.
- Actively maintain the carrying capacity of breeding habitat by burning it regularly in accordance with the Orange-Bellied Parrot Recovery Plan.
- Create new winter habitats (10 new sites in Victoria) through habitat improvement (eg remove stock grazing, planting food crops and control feral predators).
- Continue monitoring orange-bellied parrot populations.
- Conduct further research to determine the cause of the orange-bellied parrot's decline e.g. investigate the impacts of stock grazing, competition/predation by introduced species and human disturbance.

SOURCES OF INFORMATION AND COMMENT

Threatened Species Unit, Nature Conservation Branch, DPIWE. Orange-bellied parrot management: Mark Holdsworth, Wildlife Management Officer, Ph 6233 6033, Fax 6233 3477, Email markh@dpiwe.tas.gov.au

5.7.3 Endangered species: Pedder galaxias fish (*Galaxias pedderensis*)

About the value

The freshwater fish, *Galaxias pedderensis*, is listed as an endangered species under the Tasmanian *Threatened Species Protection Act 1995*.

The Pedder galaxias was naturally restricted to the original (undammed) Lake Pedder and adjoining swamps and streams. Construction of the Lake Pedder dam in 1972 and subsequent flooding of the valley was associated with a change in the overall ecology of the lake, including the establishment of the exotic brown trout and native climbing galaxias.

Following construction of the dam, there were anecdotal and unpublished reports of an increase in Pedder galaxias numbers. However surveys by the Inland Fisheries Commission in the 1980s failed to locate any specimens of Pedder galaxias and the species was listed as endangered.

An intensive survey of Lake Pedder was undertaken in 1991–1992, and a small population of Pedder galaxias was found in Bonnet Bay creeks, but none in Pebbly Creek or Swampy Creek (where they had previously been recorded).

Lake Pedder is now considered unsuitable habitat for the Pedder galaxias due to the presence of trout and the native climbing galaxid.

OVERALL MANAGEMENT GOAL: to down-list the species from Endangered to Vulnerable by establishing at least two self-maintaining translocated populations, and by developing detailed protocols for captive breeding.

Lake Pedder.
Photo by Barry Batchelor

MANAGEMENT ACTIONS AND SIGNIFICANT EVENTS OVER THE 1992–1999 PERIOD

The following management actions and/or significant events occurred over the 1992–1999 management period.

- Because the impacts on Pedder galaxias associated with construction of the Lake Pedder dam could not feasibly be reversed (e.g. removal of brown trout and climbing galaxias was not considered possible), management actions focused on establishing populations of galaxias in selected new locations that simulated their original natural habitat i.e. in natural lakes free of introduced fish species.
- The Inland Fisheries Service developed and implemented a recovery plan for the Pedder galaxias (and other threatened galaxias species including the Clarence galaxias and swamp galaxias).
- A range of management actions were implemented as part of the recovery plan including monitoring of populations, survey for new sites in the TWWHA, threat abatement to protect identified populations, erection of information signs, and public awareness raising activities, educational material and media articles focusing particularly on the impacts of fish introductions.
- Following the 1991–1992 survey of Lake Pedder, 31 individual Pedder galaxias were translocated to Lake Oberon—a remote natural lake in the Western Arthurs of the TWWHA.
- Annual surveys of Pedder galaxias numbers in Lake Pedder and Bonnet Bay creeks have been conducted since 1994.
- Surveys of Pedder galaxias in Lake Oberon were undertaken in 1996 and 1997.
- Captive breeding trials were attempted in the early 1990's but these were unsuccessful.
- In 1997, the water supply dam at Strathgordon near Lake Pedder was drained and works were carried out to convert the dam into suitable habitat for Pedder galaxias (e.g. a stream was modified to create a shallow meandering course planted with sedges and shrubs).
- More recently (in 2001 and 2002), fish from Lake Oberon have been translocated to the above site.

Results

Monitored condition indicators

Condition indicators and monitoring methodology	**Targets for condition indicators** (and how performance is assessed)	**Change in condition indicators** over the 1992–1999 period
DISTRIBUTION AND ABUNDANCE OF THE SPECIES: Annual monitoring of Lake Pedder in spring using electro-fishing. Monitoring at Lake Oberon is undertaken every two years using diving and electro-fishing to count fish. Monitoring is less frequent at Lake Oberon due to the expense of getting personnel and equipment to this remote site.	TARGET FOR DISTRIBUTION AND ABUNDANCE OF THE SPECIES: At least two self-maintaining translocated populations of Pedder galaxias in Lake Oberon and Strathgordon water supply dam by 2003. To achieve a genetically viable population, the minimum size of each of these populations should be at least 500 adult fish. ASSESSMENT OF PERFORMANCE: Results of fish surveys using diving and electro-fishing.	DISTRIBUTION AND ABUNDANCE OF THE SPECIES: The annual surveys in Lake Pedder between 1994 and 1997 located only five fish. None have been recorded in Lake Pedder since that time. Following management-initiated introduction of Pedder galaxias to Lake Oberon, surveys of Lake Oberon between 1992 and 1995 failed to locate any fish. Then in 1996, one fish was found. In 1997 eight fish were found and an underwater video survey confirmed that *Pedder galaxias* had spawned and a small breeding population had become established. The numbers of fish in Lake Oberon are steadily increasing. Recent surveys (in 2001) have recorded over 500 fish.

Outcomes

- Following translocation of a small number of fish, a natural breeding population of fish has become established in Lake Oberon.
- This result provides real hope for the future conservation security of the Pedder galaxias. The Pedder galaxias has probably been saved from extinction.

The purposeful translocation of a small number of Pedder galaxias fish to a lake that resembled the species' natural habitat in the original (pre-dam) Lake Pedder, and the subsequent successful establishment of a natural breeding population, has probably saved this species from extinction.
Photo by Ron Mawbey

Commentary on management performance

The following commentary has been provided by specialist staff within the Nature Conservation Branch of DPIWE and Inland Fisheries Service.

KEY FACTORS POSITIVELY CONTRIBUTING TO MANAGEMENT PERFORMANCE:

- Surveys of fish numbers in Lake Pedder revealed the parlous state of the species.
- Translocation of Pedder galaxias into Lake Oberon provided the potential for establishment of the species in a suitable alternative environment, and for future translocation of fish from this lake to other suitable sites.

KEY FACTORS LIMITING OR THREATENING MANAGEMENT PERFORMANCE:

- Limited number of suitable new locations for translocation of Pedder galaxias.
- Difficulty of maintaining Pedder galaxias in captivity.

SUGGESTIONS FOR IMPROVING MANAGEMENT EFFECTIVENESS

Specialist staff provided the following suggested actions for improving management of Pedder galaxias.

- Develop methods and detailed protocols for captive breeding of the Pedder galaxias.
- Establish a second translocation site for Pedder galaxias at Strathgordon.
- Continue monitoring at Lake Pedder and translocation sites.

SOURCES OF INFORMATION AND COMMENT

Dr. Jean Jackson, Native Fish Conservation, Inland Fisheries Service, Ph (03)6233 2691, Fax: (03) 6233 4141, Email: Jean.Jackson@ifs.tas.gov.au

DPIWE Fauna Section, Pedder galaxias project: Michael Driessen, World Heritage Area Zoologist, Ph 6233 3751, Fax 6233 3477, Email Michael.Driessen@dpiwe.tas.gov.au

5.7.4 Vulnerable species: pencil pine moth (*Dirce aesiodora*)

About the value

The pencil pine moth (*Dirce aesiodora*) was listed as vulnerable under the Tasmanian *Threatened Species Protection Act 1995*.

First described in 1922, by 1997 the pencil pine moth was only known from three locations in central Tasmania (Invertebrate Advisory Committee 1994). Pencil pines—on which the pencil pine moth is dependent for food—have been reduced in range as a result of wildfires.

OVERALL MANAGEMENT GOAL: to de-list the species by finding at least 5 new populations.

MANAGEMENT ACTIONS AND SIGNIFICANT EVENTS OVER THE 1992–1999 PERIOD

- A targeted 2-month survey for the species was undertaken in 1998. Widely dispersed patches of pencil pines were surveyed for the moth.

Results

Monitored condition indicators

Condition indicators and monitoring methodology	**Targets for condition indicators** (and how performance is assessed)	**Change in condition indicators** over the 1992–1999 period
NUMBER OF KNOWN LOCALITIES FOR SPECIES: Established from survey records conducted in 1998. Moths are caught in nets during summer.	TARGET FOR NUMBER OF KNOWN LOCALITIES FOR SPECIES: The target set for 1997 (to find 5 new populations of the moth) was met, and no new targets have been set.	NUMBER OF KNOWN LOCALITIES FOR SPECIES: The 1998 survey revealed a more widespread distribution of the species than was previously known. The number of known localities for the species increased from 3 (in 1997) to 16 (in 1998).
EXTENT OF PENCIL PINE HABITAT AND EXTENT OF OCCURRENCE OF PENCIL PINE MOTH: No formal monitoring program for the distribution of Pencil Pine habitat is in place. Vegetation mapping has shown that pencil pine rainforest and pencil pine deciduous beech rainforest cover 9,577 ha in Tasmania (Kirkpatrick et al 1995).	TARGET: None set	The extent of occurrence of the Pencil Pine moth is estimated to be 3,600km^2 and its area of occupancy is about 9,000 ha—all in the central highlands of Tasmania (Bell, 1998).

Outcomes

- Surveys revealed that the distribution and abundance of the Pencil Pine moth was significantly greater than previously known.
- The pencil pine moth has been de-listed as a result of these findings.

COMMENTARY ON MANAGEMENT PERFORMANCE

The following commentary has been provided by specialist staff within the Nature Conservation Branch of DPIWE.

KEY FACTORS POSITIVELY CONTRIBUTING TO MANAGEMENT PERFORMANCE:

- Securing of funding from World Heritage Area Project funds to undertake surveys for the species. These surveys resulted in an improved knowledge base for the species and resulted in the discovery of many previously unknown populations of the Pencil Pine moth.

KEY FACTORS LIMITING OR THREATENING MANAGEMENT:

- None (although still potential from disease and fire to reduce critical habitat of Pencil Pines)

SUGGESTIONS FOR IMPROVING MANAGEMENT EFFECTIVENESS

Specialist staff provided the following suggested actions for improving management of the pencil pine moth.

- Protect pencil pine stands from fire and disease.
- Monitor the distribution and conservation status of Pencil Pine habitat in Tasmania.
- If the conservation status of Pencil Pine habitat declines, review the moth's conservation status.

SOURCES OF INFORMATION AND COMMENT

DPIWE Fauna Section, Pencil Pine moth project: Michael Driessen,
WHA Zoologist, Ph 6233 3751, Fax 6233 3477,
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Pencil pines (*Athrotaxis cupressoides*).
Photo by Nick Sawyer

5.7.5 Vulnerable species: blind cave beetle (*Geodetrechus mendumae*)

About the value

The blind cave beetle (*Goedetrechus mendumae*) was listed as vulnerable under the Tasmanian *Threatened Species Protection Act 1995*.

The blind cave beetle was first described in 1972, when it was only known from a small section of passage (less than 150m length) in Exit Cave. Exit Cave habitat was, at that time, under threat from a limestone quarry operation adjacent to the cave system, and from disturbance by recreational cavers.

The blind cave beetle only occurs in caves, mostly in the deep cave zone. Because the species is so specialised in its habitat and has low numbers of populations, it is also vulnerable to extinction from random (stochastic) events.

OVERALL MANAGEMENT GOAL: to protect known sites and to identify further locations where the species occurs.

MANAGEMENT ACTIONS AND SIGNIFICANT EVENTS OVER THE 1992–1999 PERIOD

A three-month systematic survey of the Ida Bay Caves was undertaken in the summer of 1997 to locate live specimens of the blind cave beetle or the remains of dead specimens.

Results

Monitored condition indicators

Condition indicators and monitoring methodology	**Targets for condition indicators** (and how performance is assessed)	**Change in condition indicators** over the 1992–1999 period
NUMBER OF KNOWN LOCALITIES FOR SPECIES: Established from survey records from the three-month survey in summer 1997 of the Ida Bay Caves.	TARGET FOR NUMBER OF KNOWN LOCALITIES FOR SPECIES: The original target of finding further locations where the blind cave beetle occurs has been met. No new targets have been set.	NUMBER OF KNOWN LOCALITIES FOR SPECIES: The 1997 survey found populations of the blind cave beetle in two new locations in Mystery Creek Cave. Indirect evidence (dead material) suggested the species is more widely distributed in Exit Cave. These findings mean that the threat of extinction of the beetle (e.g. through random events) is not as high as previously thought.

Outcomes

- The distribution of the blind cave beetle is more widespread than previously known (although still restricted to one cave system), and consequently the threat of extinction of the beetle is not as high as previously considered.

Commentary on management performance

The following commentary has been provided by specialist staff within the Nature Conservation Branch of DPIWE.

KEY FACTORS POSITIVELY CONTRIBUTING TO MANAGEMENT PERFORMANCE:

- Securing of WHA project funding to undertake surveys for the species.
- Surveys improved the knowledge base for the species.
- Closure of Benders limestone quarry in 1992.
- Voluntary avoidance by recreational cavers of the relevant small section of passage in Exit Cave (Keller's squeeze).

KEY FACTORS LIMITING OR THREATENING MANAGEMENT PERFORMANCE:

None identified.

SUGGESTIONS FOR IMPROVING MANAGEMENT EFFECTIVENESS

Specialist staff provided the following suggested actions for improving management of the blind cave beetle.

- Continue protecting vulnerable habitat locations of the species in Ida Bay karst/caves e.g. maintain access restrictions to Keller's squeeze (a small contained area where animals and their habitat could be affected by recreational caving).
- Monitor visitor numbers accessing known locations of blind cave beetles.
- Undertake further surveys for the blind cave beetle in Loons cave, Bradley Chestermans Cave and Arthurs Folly.
- Undertake regular monitoring of species and habitat at selected sites, e.g. monitor populations of the blind cave beetle every 5 years by undertaking searches in known locations as well as other potential sites.

SOURCES OF INFORMATION AND COMMENT

DPIWE Fauna Section, Blind cave beetle project: Michael Driessen, WHA Zoologist, Ph 6233 3751, Fax 6233 3477, Email: Michael.Driessen@dpiwe.tas.gov.au

5.7.6 Rare species: New Zealand fur seal (*Arctocephalus forsteri*)

About the value

The New Zealand fur seal (*Arctocephalus forsteri*) is listed as rare under the Tasmanian *Threatened Species Protection Act 1995*.

New Zealand fur seals (along with Australian fur seals and Australian sea lions) historically bred on Bass Strait and other Tasmanian offshore islands. Elephant seals also had breeding colonies right around Tasmania. The former seal industry virtually eliminated all seals and sea lions from the entire Australian region. While Australian fur seals have re-established haulouts around the Tasmanian coastline, their breeding colonies are now restricted to Bass Strait. Australian fur seals are currently restricted to Bass Strait Islands while Australian sea-lions remain absent from Tasmanian islands. Elephant seals are restricted to a tiny colony on Maatsuyker Island (off the south coast of Tasmania, and part of the TWWHA).

In 1987, surveys undertaken by DPIWE discovered NZ fur seals breeding on Maatsuyker Island.

OVERALL MANAGEMENT GOAL: to document the abundance and trend of the NZ fur seal population on Maatsuyker and adjacent islands.

MANAGEMENT ACTIONS AND SIGNIFICANT EVENTS OVER THE 1992–1999 PERIOD

- Annual counts of NZ fur seal pups have been undertaken by the managing agency every March since 1989.

Following its virtual elimination from the entire Australian region as a result of the former seal industry, the New Zealand fur seal (listed as rare under the Tasmanian *Threatened Species Protection Act 1995*) has established a breeding colony at Maatsuyker and nearby islands.
Photo by Nature Conservation Branch

Results

Monitored condition indicators

Condition indicators and monitoring methodology	**Targets for condition indicators** (and how performance will be assessed)	**Change in condition indicators** over the 1992–1999 period
ANNUAL NUMBER OF SEAL PUPS: Annual monitoring of seal pups using counts and capture-mark-recapture since 1989.	TARGET: None set.	The annual number of seal pups has increased from 40 in 1989 to 120 in 1996. The current total pup production is in the order of 150 pups per year.
BREEDING RANGE OF FUR SEALS (within their former natural range): Surveys conducted of southern islands	TARGET: None set.	The breeding range of NZ fur seals in Tasmania has expanded since 1989 from Maatsuyker Island, with pups now recorded on both Walker and Flat Witch Islands.

Outcomes

- The breeding production of NZ fur seals in Tasmania has increased since monitoring commenced in 1989.
- The breeding range of fur seals has expanded from Maatsuyker Island to other islands within the Maatsuyker group.
- NZ fur seals persist in low numbers in the southwest of Tasmania although they are increasing at other Australian locations e.g. Kangaroo Island in South Australia.

Commentary on management performance

The following commentary has been provided by specialist staff within the Nature Conservation Branch of DPIWE.

KEY FACTORS POSITIVELY CONTRIBUTING TO MANAGEMENT PERFORMANCE:

- There has been a shift in community attitudes away from acceptance of shooting of wildlife including seals.

KEY FACTORS LIMITING OR THREATENING MANAGEMENT PERFORMANCE:

- Costs and logistics associated with access to islands to conduct seal surveys.
- Expert identification is required to positively differentiate between Australian and NZ fur seals.
- Design of the pup production surveys has to take account of potential disturbance to the seals.

SUGGESTIONS FOR IMPROVING MANAGEMENT EFFECTIVENESS

Specialist staff provided the following suggested actions for improving management of NZ fur seals.

- Undertake on-going monitoring of population trends and identification of threats.
- Liaise with community sectors that pose a threat to seals, especially the fishing industry.
- Investigate the potential of genetic hybridisation between NZ and Australian fur seals.

SOURCES OF INFORMATION AND COMMENT

PWS Marine Unit, NZ fur seal project: Rosemary Gales, Zoologist, Ph 6233 3865, Fax 6233 3477, Email rosemaryg@dpiwe.tas.gov.au