TASMANIA PARKS AND WILDLIFE SERVICE

Natural Values

Status and Trends in the Condition of Natural Values in the Tasmanian Wilderness World Heritage Area (TWWHA)

unesco
World Heritage site

Acknowledgement: We acknowledge Tasmanian Aboriginal people as the custodians of this Land, and pay respects to Elders past and present for they hold the knowledge, memories and culture of First Nations people in Tasmania. The Parks & Wildlife Service (PWS) also wishes to thank the National Parks and Wildlife Advisory Council and Aboriginal Heritage Council for their advice and contribution to the preparation of this Status and Trends report.

NATURAL RESOURCES AND ENVIRONMENT TASMANIA

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COVER IMAGE: The beautiful Eastern pygmyfly *(Nannophya dalei)* is a type of small dragonfly which lives in and around boggy seepages and swamps in the Tasmanian Wilderness World Heritage Area Photo: Mike Driessen

Tasmanian Government

Australian Government

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Introduction

Reliable information and measured evidence about the condition of the Tasmanian Wilderness World Heritage Area (TWWHA) values is vital to guide sound and adaptive management of the property.

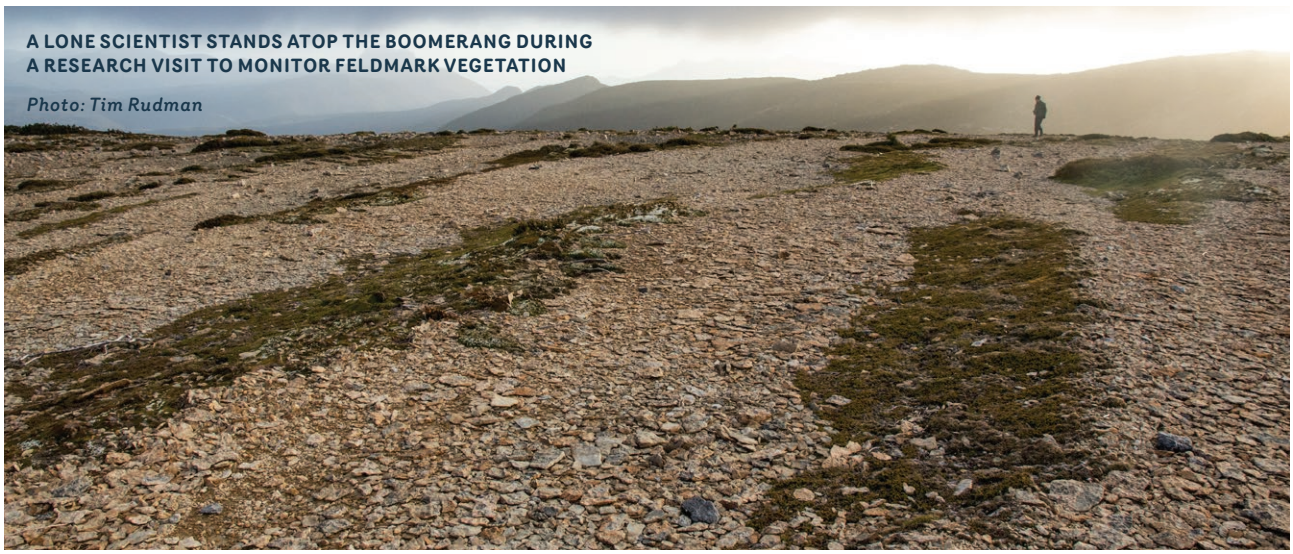
Status and Trends reports provide a summary of our current understanding and the current condition (status) of key values and any change in condition over time (trend). Monitoring and reporting on the condition and trend in condition of the natural values of the TWWHA supports the delivery of an informed, effective, and transparent, adaptive management regime for the TWWHA. Often though, quantitative data from monitoring are not available or we only have limited data. In these cases, we rely on expert opinion to manage some values, understanding that our level of confidence is reduced because of this lack of data.

The ecosystems within the TWWHA are of outstanding significance for their exceptional natural beauty, distinctive landforms, palaeoendemic species and communities, unusual threatened plants and animals, and ecological processes that result in some of the tallest vegetation in the world. The size of the property provides an opportunity for the protection of endemic species, many of which are rare or threatened plants and animals. There is also a diversity of secure habitats, including island refuges that contain very few pathogens, weeds or pests. We are still building our knowledge base about the values, their state, and threats to them. As we undertake further monitoring and investigations, our confidence increases in our ability to assess the condition of the value and any trend in that condition.

This is the first Status and Trends Report on the condition of natural values within the TWWHA. This report assesses the values, what we have learned about them, their condition and where we have the necessary information, if it is changing over the period 2004-2019.

Guiding vision for management of the TWWHA

The guiding vision for management of the TWWHA is: '*To identify, protect, conserve, present, and if appropriate, to rehabilitate the World Heritage, National Heritage and other natural and cultural values of the TWWHA and to transmit that heritage to future generations in as good or better condition than at present.*'



A LONE SCIENTIST STANDS ATOP THE BOOMERANG DURING A RESEARCH VISIT TO MONITOR FELDMARK VEGETATION

Photo: Tim Rudman

CRADLE MOUNTAIN REFLECTED IN THE STILL WATERS OF DOVE LAKE

Photo: Bruce Cooper

Basis for evaluation

The statutory TWWHA Management Plan 2016 provides the primary basis for evaluating management effectiveness. The plan's guiding vision plus the specific statements of Key Desired Outcomes (KDOs) provides clear statements of management intent and what management is aiming to deliver to ensure the maintenance of condition of the natural values.

The Management Plan specifies how the Outstanding Universal Value (OUV) of the property is preserved and managed to promote effective protection of the property for present and future generations. Management arrangements for the whole of the property address development control provisions, presentation, cooperative management, community engagement, and monitoring, evaluation and reporting.

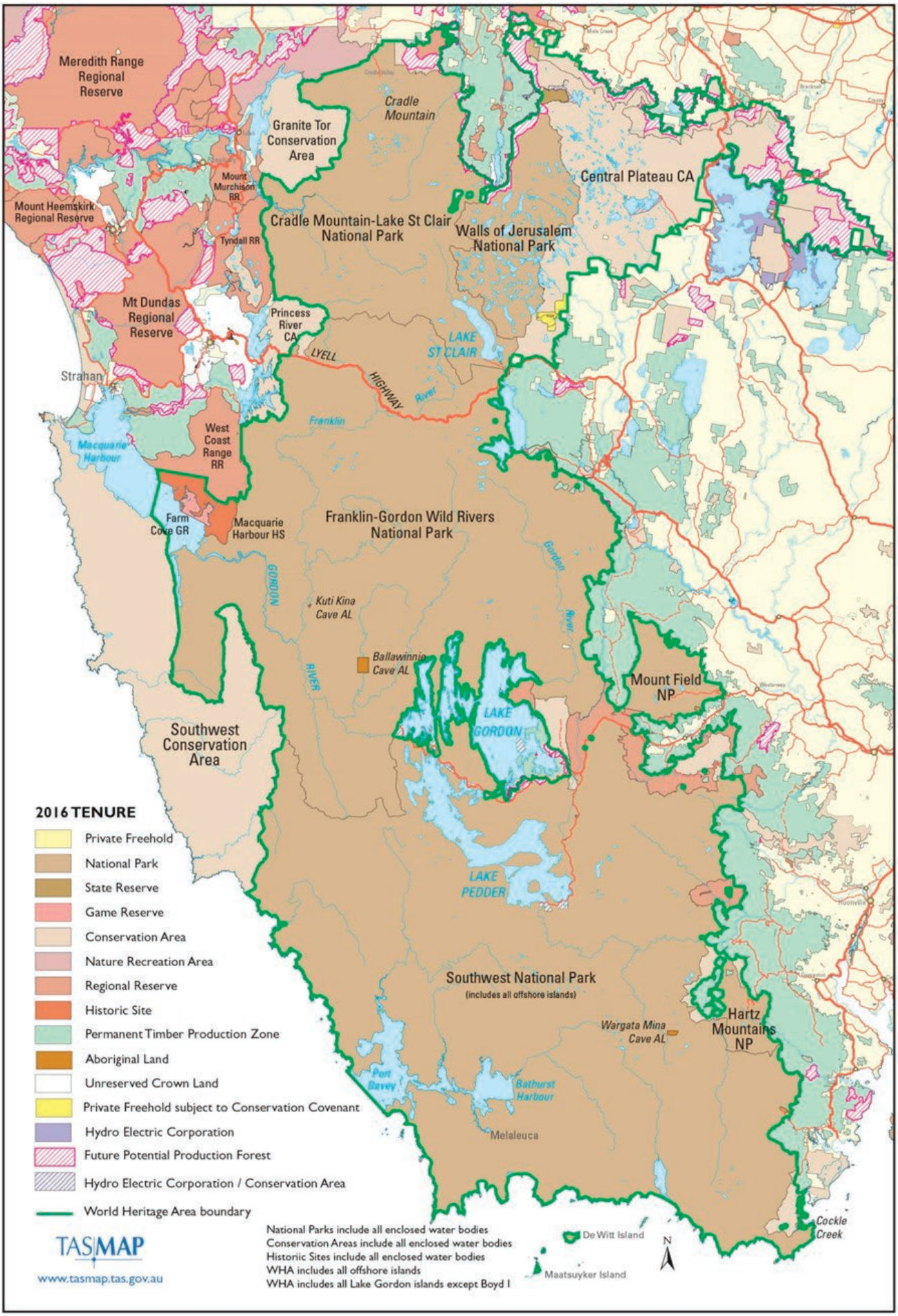
Underpinning successful management and the achievement of the Management Plan vision, is our monitoring and assessment of the values of the TWWHA and how they are changing over time in response to threats and our management actions. This monitoring and assessment provides the foundation data that underpin our Monitoring and Evaluation Framework for the TWWHA and its Key Evaluation Questions (KEQs). The current scientific understanding and data on condition and trends contained in this Status and Trends report contributes to our assessment of the Framework's **KEQs 3** and **4**. These KEQs will be assessed as part of the State of the TWWHA reporting exercise. We present these two KEQs here for context only.

KEQ 3

Are the key threats, risks and impacts to the TWWHA and its Outstanding Universal Value identified and effectively managed?

KEQ 4

What is the condition and trends of the natural and cultural values of the TWWHA?


Meredith Range Regional Reserve
Granite Tor Conservation Area
Cradle Mountain
Central Plateau CA
Mount Murchison RR
Mount Heemskirk Regional Reserve
Tyndall RR
Cradle Mountain-Lake St Clair National Park
Walls of Jerusalem National Park
Mt Dundas Regional Reserve
Princess River CA
LYELL HIGHWAY
LAKE ST CLAIR
River Franklin
Strahan
West Coast Range RR
Macquarie Harbour
Farm Cove GR
Macquarie Harbour HS
Franklin-Gordon Wild Rivers National Park
GORDON RIVER
Kuti Kina Cave AL
Ballawinnia Cave AL
Gordon River
Mount Field NP
LAKE GORDON
Southwest Conservation Area
LAKE PEDDER
Southwest National Park
(includes all offshore islands)
Wargata Mina Cave AL
Hartz Mountains NP
Port Davey
Bathurst Harbour
Melaleuca
Cockle Creek
De Witt Island
Maatsuyker Island
N
2016 TENURE
Private Freehold
National Park
State Reserve
Game Reserve
Conservation Area
Nature Recreation Area
Regional Reserve
Historic Site
Permanent Timber Production Zone
Aboriginal Land
Unreserved Crown Land
Private Freehold subject to Conservation Covenant
Hydro Electric Corporation
Future Potential Production Forest
Hydro Electric Corporation / Conservation Area
World Heritage Area boundary
TASMAP
www.tasmap.tas.gov.au
National Parks include all enclosed water bodies
Conservation Areas include all enclosed water bodies
Historiic Sites include all enclosed water bodies
WHA includes all offshore islands
WHA includes all Lake Gordon islands except Boyd I

Statements of Key Desired Outcomes

The TWWHA Management Plan stated KDOs that relate to the condition of TWWHA natural values that have applied over the period 2004-2019 are reproduced in the following table.

Key Desired Outcomes for the condition of TWWHA natural values

	STATEMENTS OF KEY DESIRED OUTCOMES (KDOS)
	KDO 5.2 Research and monitoring programs in the TWWHA provide an understanding of trends in the conservation status of priority natural values, identify risks to those values, support the development of management strategies, and allow for rigorous assessment of management effectiveness. KDO 5.7 Monitoring of natural values supports both the development of management strategies and actions that prevent or mitigate the potential impact of usage in the TWWHA, and the evaluation of management effectiveness. KDO 5.8 The aesthetic qualities of the TWWHA are maintained or improved. KDO 5.9 Threatened species and ecosystems remain at least stable or increase in population or extent. KDO 8.5 Wilderness is managed for the protection of the integrity, and the natural and cultural values, of the TWWHA and the quality of the recreational experience it provides.
TWWHA Management Plan 1999-2016	KDO 4.1 Maintenance or restoration of natural diversity and processes. KDO 4.2 Maintenance or enhancement of wilderness quality. KDO 4.3 Maintenance or enhancement of environmental quality. KDO 4.4 Maintenance or enhancement of landscape quality. 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.

Assessing whether or not our management of the TWWHA is answering our Framework's KEQs and their supporting evaluation questions, or achieving the Management Plan's KDOs and maintaining the OUV of the property, can be informed by anecdotal, scientific expert opinion or published evidence. Whilst published evidence is always our preferred goal, we also recognise the value of the opinions and experience of our on-ground staff and researchers. Garnering the opinions of all those involved in aspects of managing the property helps us identify current and future risks and threats to the values. Managing for these threats and assessing impacts of these threats on the values not only puts our assessment of status and trends into a broader management context but helps guide mitigation actions to reduce the threat and its impact.

All assessments of status and trends benefit from established and repeated monitoring and reporting over time and it is our hope that such monitoring will be enhanced in future years to build on our understanding of the natural values of the TWWHA and how they contribute to the OUV, assess their condition, monitor the threats and how the values may be changing, and address the Key Evaluation Questions from our Monitoring and Evaluation Framework for the TWWHA.

What makes the TWWHA so special?

To be included on the World Heritage List, sites must have OUV meeting at least one of ten listing criteria. Securing World Heritage listing for the TWWHA in 1982 was achieved on the basis of meeting all four natural values World Heritage criteria (criteria vii, viii, ix, and x) and three cultural criteria (iii, iv, vi). The following table displays the key natural values used to justify each of the four natural values criteria and collectively these attributes help establish the property's OUV. Broadly, the meaning of OUV follows the normal use interpretation of each word:

Outstanding: properties of Outstanding Universal Value should be exceptional, or superlative – they should be the most remarkable places on earth.

Universal: properties need to be outstanding from a global perspective. World Heritage does not aim to recognise properties that are remarkable only from a national or regional perspective.

Value: What makes a property outstanding and universal is its "value", or the natural and/or cultural worth of a property.

WINDOW PANE BAY BEACH AT DAWN

Photo: Tim Rudman

CRITERIA	WORLD HERITAGE CRITERIA	NATURAL VALUE	DESCRIPTION
vii	superlative natural phenomena or areas of exceptional natural beauty	Undisturbed wilderness and spectacular landscapes	Mostly undisturbed wilderness with spectacular landscapes ranging from previously glaciated mountains and alpine meadows to buttongrass moorlands, towering forests, untamed rivers and wild coastal scenery, the longest undisturbed stretch of temperate embayed rocky and sandy coastline in the world.
		The majority of the world's tallest flowering trees forming the largest patches of awe-inspiring very tall forests	Towering eucalyptus forests which include the largest and most intact known patches of forest with average crown height of over 70 metres and the majority of the world's flowering trees over 90 metres in height.
		Wild temperate coastline	The longest undisturbed stretch of temperate embayed rocky and sandy coastline in the world, with spectacular headlands, beaches, lagoons, islets and cliffs and a rugged windswept archipelago.
viii	outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features	Exceptional expression, diversity and scale of karst features going back up to 400 million years	Extensive scale and very high diversity of ongoing and undisturbed karst processes, including palaeokarst development going back up to 400 million years, hydrothermal karstification and evidence of past glacio-karstic interactions.
		Exceptionally broad range of geomorphological phenomena and processes	Rocks from almost every geological period from the Neoproterozoic onwards and geomorphological features from past glacial events including one of the best available global records of temperate glacial processes during the Late Cainozoic Ice Age. This exceptionally broad range of ongoing geomorphological and soil processes continue to operate in a largely unmodified fashion.

CRITERIA	WORLD HERITAGE CRITERIA	NATURAL VALUE	DESCRIPTION
ix	outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals	Ongoing ecological processes with high degree of naturalness at a large-scale	A wide variety of largely undisturbed ecosystems conserved in the property provides for the continuance of longstanding ecological processes. These processes have, in combination with the geographic isolation, resulted in an unusually high degree of floral and faunal endemism. The property is also renowned internationally for the extreme longevity of some of its flora, the oldest of which has been dated as at least 43 000 years old.
		Unique diversity of ancient taxa	A unique diversity of ancient taxa, particularly relict groups with ancestry dating back to the super continent of Gondwana.
		Tracts of undisturbed peatlands and moorlands	The buttongrass moorlands of Tasmania are the best expression of a vegetation type with no close analogue outside. The creation of a significant number of these moorlands is linked to long term Aboriginal fire management regimes over thousands of years. The accumulation of peatlands and development of blanket bogs is a complex interaction between climatic, geomorphic and floristic variables. The process of vegetation succession and impacts of fire are exemplified in buttongrass moorlands which provide habitat for a unique array of bird and invertebrate fauna.

CRITERIA	WORLD HERITAGE CRITERIA	NATURAL VALUE	DESCRIPTION
x	contain the most important and significant natural habitats for in-situ conservation of biological diversity	High plant biodiversity with exceptional proportion of relict and endemic species	Exceptional relict and endemic plant species include several endemic conifers, such as the King Billy pine, Huon pine and other plant genera with Gondwanan links. The King's holly appears to have been in existence for at least 43,000 years, making it one of the oldest documented vascular plants in the world.
		Relict and endemic mammals	Endemic mammals include the Tasmanian devil; Eastern quoll and long-tailed mouse. Examples of relict mammals include Tasmanian platypus, short-beaked echidna and spotted-tail quoll.
		Rare, relict and endemic birds	11 of the 135 native bird species recorded are endemic to Tasmania. The Tasmanian wedge-tailed eagle - Australia's biggest bird of prey - is an endangered subspecies endemic to the island. Other bird species include the critically endangered orange-bellied parrot and the ground parrot.
		Relict and endemic frogs	Of the seven native frog species known to occur in the property, three are endemic to Tasmania. The endemic Tasmanian froglet, moss froglet, and Tasmanian tree frog are believed to have Gondwanan origins.
		Endemic and threatened skinks	Of the 14 native reptiles species occurring in the property, seven are endemic skinks including the mountain skink, northern snow skink, southern snow skink and the Pedra Branca skink which is restricted to Pedra Branca Island.
		Endemic and threatened freshwater fish	16 recorded species of native freshwater fish within the property, including four endemic species. The swamp galaxias, Pedder galaxias and the western paragalaxias are restricted to the property and the distribution of the Clarence galaxias is primarily restricted to the property.
		Enormous diversity of relict and endemic groups of invertebrates	Enormous diversity of relict and endemic invertebrates, including for example velvet worms; harvestman, pseudoscorpions and the spider families Austrochilidae, Migidae and Orsolobidae, including the Tasmanian cave spider; aquatic insect groups with close affinities to groups found in South America, New Zealand and Southern Africa (e.g. dragonflies, chironomid midges, stoneflies, mayflies and caddisflies); crustaceans; primitive taxa showing links to fauna more ancient than Gondwana.

Understanding Condition Assessments

The following series of tables and graphics attempt to present the various natural values of the TWWHA that make the TWWHA so special, focusing on the World Heritage listing criteria, the ability of a range of habitats across the property to sustain the unique populations of the TWWHA, and assessments of the known condition of a range of attributes. Our approach adapts the International Union for Conservation of Nature (IUCN) method in use since 2011 for World Heritage Area conservation assessments. It makes use of a condition rating system with four categories: 'good'; 'good with some concern'; 'significant concern'; 'unsatisfactory'.

We have coupled this rating, determined using both data or expert opinion, with a consideration of the trend in condition of the value as well as an assessment of how confident we are in making these claims.

To help the reader interpret the information contained in the assessment rating tables and 'star wheel' infographics, a guide to understanding the information is provided on the following two pages.

STAND OF PANDANI AMONGST THE SNOW AT HANGING LAKE IN THE EASTERN ARTHUR RANGE

Photo: Kath Storey

A guide to understanding the information on the following pages

Trend Assessment

Trend assessment is shown by these symbols with a **'?'** used to show an unknown trend.

Trend

- Improving
- Stable
- Declining
- Mixed
- ? Unknown

Evidence Availability

The amount of evidence (published or scientific opinion) available to help make our assessment.

Evidence Availability

- Substantial evidence or level of consensus
- Adequate evidence or consensus for decision making
- Inferred due to very little or no evidence or consensus
- Growing levels of evidence or level of consensus
- Limited evidence or limited consensus

Assessment Confidence Level

Two ticks describes the known (with some degree of confidence) majority condition rating of a value or attribute across the entire TWWHA.

One tick signifies a low level of confidence around the condition assessment score due to a paucity of data on the value or attribute. In such cases expert opinion is utilised to make the assessment.

An overall condition summary and rating is also given for the category, considering all of the known and likely condition assessments of the values and attributes.

Assessment Confidence Level

- ✓✓ Rated with confidence
- ✓ Limited confidence

Assessment Rating definition

The rating categories used for each assessment and their definition: Good; Good with some concern; Significant concern; and Unsatisfactory.

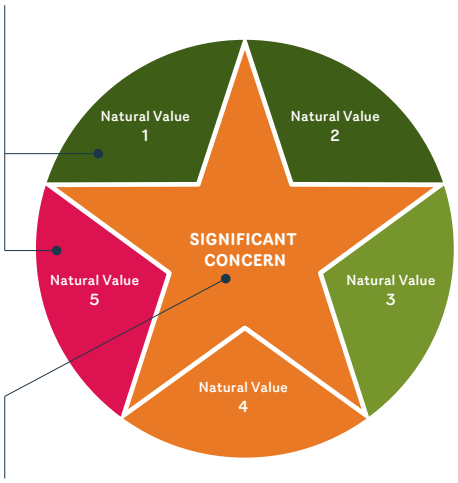
Assessment Rating definition

- **Good** – all values are essentially intact and in excellent condition. Integrity of the TWWHA remains intact preserving the attributes that comprise the OUV of the property.
- **Good with some concern** – some loss of condition or alteration has occurred in a few areas. The Integrity of the TWWHA is experiencing a slight deterioration impacting the resilience of some areas and values.
- **Significant concern** – condition deterioration or loss has occurred in a number of areas. The Integrity of the TWWHA is deteriorating and the size of the property is becoming less effective as a buffer against disturbance.
- **Unsatisfactory** – widespread loss or alteration is occurring causing severe declines in the condition state of values.

Star Wheels

The 'star wheel' infographic summarises the more detailed condition rating statements and presents them around the perimeter of the wheel. Then, taking into account the value condition ratings around the perimeter, makes an assessment of the overall condition rating which is shown in the centre. In this way it simplifies the presentation of the information and allows the reader to visualize a quick snapshot of the issues, values and condition. A generic template for interpreting how a 'star wheel' can be used to describe an assessment of condition is shown below.

Natural Value Category



Overall assessment rating arrived at after assessment of each Natural Value category and the values within each category

Assessment rating – colour coded

- Good
- Good with some concern
- Significant concern
- Unsatisfactory

Threat Legend

The tables starting on page 24 use the icons and threat impact ratings shown below.

Threat Legend

- Fire
- Climate Change & Extreme Events
- Sea Level Rise
- Pollution
- Development
- Overuse
- Walkers & Fishers
- Dams and water regulation
- Disease
- Pest animals
- Weeds
- Aircraft
- Boats & Watercraft
- Illegal activities

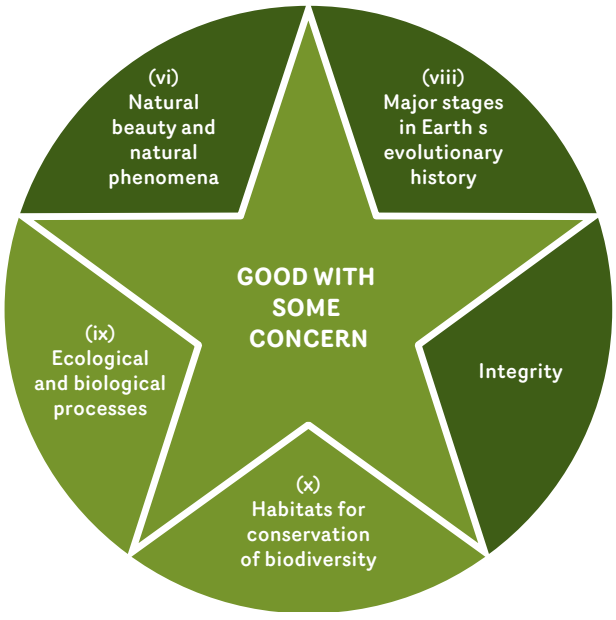
Threat Impact ranking

- Severe
- Major
- Moderate
- Minor
- Insignificant

Summary Assessment

This report examines our current understanding of the natural values of the property that contribute to the relevant four natural World Heritage listing criteria and the OUV, their condition, and where information allows, the trend in that condition over the last 15-20 years.

The report focusses on ecosystems and habitats across the property and their ability to support natural diversity, the condition of natural values and ecological processes across the property, and a range of physical and environmental attributes contributing to the exceptional natural beauty and undisturbed wilderness character of the property, including landscape wilderness quality, and environmental quality.



WORLD HERITAGE LISTING CRITERIA

World Heritage Listing Criteria

Our assessment of the four World Heritage listing criteria for the natural values suggests that the values originally used to obtain listing remain virtually unchanged from that time. The four criteria have been assessed as still in a condition of 'good' or 'good with some concern'. The TWWHA remains a globally significant example of a system of complex ecosystems that has evolved over millions of years. The superlative natural beauty of the property remains virtually unchanged. The property can therefore be considered as retaining the same attributes that satisfied the four natural criteria for which the property was originally listed and that contribute to its OUV.

In the national and global context, the TWWHA is amongst the largest, most intact and least disturbed wilderness areas in the world. The 2013 extensions to the property boundary further enhanced the degree of intactness and naturalness of the property, providing enduring World Heritage protection for additional significant natural and cultural values, such as stands of giant eucalypts. Our assessment rating of integrity is influenced by the outstanding wilderness quality of the property further enhanced by the 2013 extension to the property with even more habitats of sufficient size added that provide the greatest opportunity for the survival of the rare Gondwanan plants and animal species. This increase in the size of the property in combination with the Management Plan for the property, provides a high degree of protection for the natural values and ensures the sustainability of these unique temperate wilderness ecosystem functions.

Natural Values Condition

The condition of natural values across the TWWHA is generally thought to be good but we do have some concerns. Whilst we feel reasonably confident in making this assessment we recognize that there is often limited information or evidence available for many of the values, meaning our assessments are often framed on the basis of known threats, expert opinion or conceptual understanding of the value. However, our confidence in our assessment is supported by assessment ratings of 'good with some concern' by both a) the United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Committee Reactive Monitoring Mission in 2015; and b) the independent 2020 Conservation Outlook Assessment report. We know that disease, invasive pests, and weeds, and increased bushfire intensity and frequency have impacted some values in different parts of the property. For example, fire-sensitive vegetation communities, including high conservation value ancient forests of endemic conifers and alpine vegetation communities as well as combustible organic peat soils have been adversely impacted by bushfires since 2015. There are several threatened endemic freshwater fish species within the TWWHA whose distribution has been affected by trout, and there remains a risk of trout spreading further into streams and rivers where native fish persist. In terms of threats, fallow deer incursion along the north-eastern boundary of the property, weed incursion in the Extension areas, and climate change impacts more generally and the resultant extreme events, remain the key threats to natural values of the TWWHA.

Geographical Area Assessment

The geographical areas of the TWWHA each have their own particular set of values, and depending upon the level of development or the fire history, the condition assessments of values and attributes within these areas can be quite different from the same value in another part of the TWWHA. The Central Plateau is the worst affected area, with ancient pencil pines and extensive areas of organic soils impacted by fires, and climate change now expected to impact water levels of the thousands of small lakes and waterbodies.

The coast and estuarine environments are showing the effects of erosion and weed colonisation, whilst the hydroelectric operations of the Gordon Dam have led to three small lakes along the Lower Gordon River, losing their state of meromixis — an uncommon state of lakes where the annual intermixing of water layers does not occur.

NATURAL VALUES CONDITION ASSESSMENT

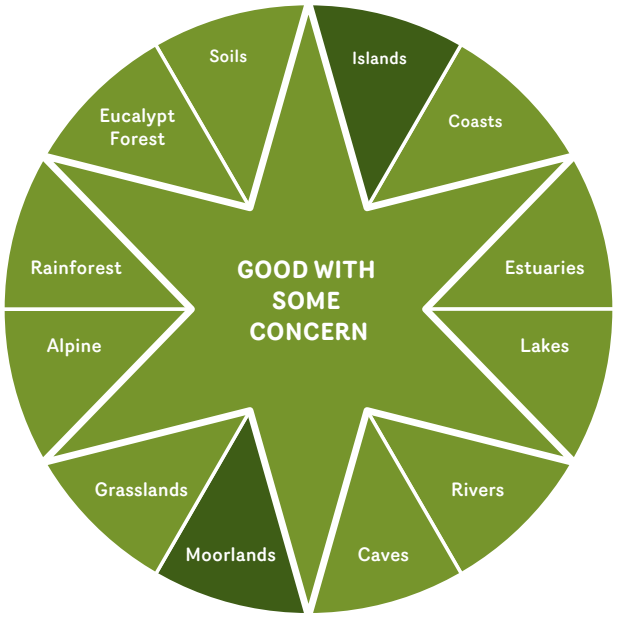
GEOGRAPHICAL AREA ASSESSMENT

Habitats

The range of habitats across the TWWHA are generally in a condition assessed as 'good with some concern'. The habitats in the best condition are the **islands** and the **moorlands**. The former is due to the pristine or near pristine nature of virtually all of the thousands of islands and outcroppings. The moorlands and their buttongrass vegetation, are adapted to fire and have recovered well following each of the bushfires during the period, provided the underlying peat has not burnt down to mineral substrate.

Environmental Quality Attributes

The environmental quality aspects of the property are assessed as 'good with some concern'. The outstanding landscape wilderness quality of the TWWHA has generally been maintained although some minor changes in mapped wilderness quality have occurred over the period 2005 to 2015. Litter and noise are also issues in some parts of the property, resulting in Environmental Cleanliness and Soundscape and Natural Ambience assessment ratings of 'good with some concern'. Despite issues with introduced trout in many of the creeks and rivers of the TWWHA, water quality remains excellent with the large majority of assessed creeks rated as near pristine. Air quality is globally outstanding due to the prevailing winds. The night skies are renowned for their darkness providing an outstanding opportunity to view the Milky Way and the Aurora Australis.



HABITAT ASSESSMENT

ENVIRONMENTAL VALUES ASSESSMENT

World Heritage natural value listing criteria assessment

Current Summary and Assessment

World Heritage values and National Heritage values: ⟷ ◑

The OUV of the property remains intact. The TWWHA remains a globally significant example of a system of complex ecosystems that has evolved over millions of years. The superlative natural beauty of the property remains virtually unchanged. The integrity of the property in combination with the wide range in habitats and specialised ecosystems means that the natural values continue to retain resilience in the face of increasing threats driven by climate change. Our overall assessment rating is 'good with some concern'.

(vii) Natural beauty and natural phenomena: ⟷ ●

The spectacular natural beauty and wilderness character of the TWWHA remains intact. Most natural phenomena remain undisturbed.

(viii) Major stages in Earth's evolutionary history: ⟷ ◕

The landscape of the TWWHA retains its outstanding evolutionary history.

(ix) Ecological and biological processes: ✣ ◑

Most ecosystem processes remain in good condition but there are some localised concerns caused by bushfire impacts, introduced species, disease and weeds.

(x) Habitats for conservation of biodiversity: ✣ ◑

The TWWHA remains an outstanding example of a complex mosaic of habitats that provide protection for many endemic species. However there is growing concern about habitat loss due to bushfire and alpine ecosystem impacts resulting from temperature shifts caused by climate change. The endangered Orange-bellied Parrot population remains at critically low numbers but 2020 bird returns have been the best for some years.

Integrity ⟷ ◕

The property is large enough to ensure representation of its World Heritage values, continuing to demonstrate the interaction between people and the landscape over millennia. It retains an exceptional degree of intactness and high degree of naturalness. The adoption of the property's Management Plan 2016 ensures it is being comprehensively managed.

Natural Value attributes of the TWWHA – assessment of condition

Vegetation

The overall condition of vegetation communities across the TWWHA remains 'good with some concern' due to fire impacts and presence of phytophthora disease.

Mammals

The overall condition of the mammal population of the TWWHA is thought to be 'good with some concern' due to the potential for disease, climate change impacts, invasive species and increases in human access (by foot, boat and air).

Birds

The overall condition of the bird population of the TWWHA is considered 'good with some concern', with the endangered Orange-bellied Parrot population improving but still threatened.

Fish

The overall condition of fish communities in the rivers of the TWWHA is thought to be 'good with some concern' due to presence on the introduced brown trout.

Invertebrates

The overall condition of invertebrates in the TWWHA is thought to be very good however a lack of data limits our ability to make an informed assessment.

Beaches & Dunes

Due to their remoteness, the condition of beaches and coastal dunes is considered 'good with some concern' due to dune erosion and weed infestation.

Soils

Impacts from fires, increased visitation, unauthorised vehicular access and a warming/drying climate has affected both mineral and organic soil landscapes in parts of the TWWHA reducing their overall condition assessment score to 'good with some concern'.

Estuaries

The overall condition of estuaries and harbour ecosystems is thought to be 'good with some concern' due to a lack of extensive data collection apart from the Macquarie Harbour studies associated with fish farming outside of the TWWHA boundary.

Lakes

The lakes of the TWWHA are likely to be near pristine and therefore their condition is rated as 'good', although a lack of data remains a concern.

Rivers

The majority of rivers of the TWWHA are assessed as likely being in near pristine condition although the known presence of trout in many and their impact on native fish, means that our overall rating is assessed as 'good with some concern'.

Caves & Karst

The condition of known cave systems remains 'good with some concern' due to visitor impacts. The large number of undiscovered caves are thought to be in 'good' condition.

Fossils

Known fossil sites are considered to be in 'good' condition.

Natural Values Overall Condition Summary

TWWHA Natural values

Whilst some values of the TWWHA are in 'good' condition many are assessed as 'good with some concern'. The overall condition rating for natural values is therefore assessed as 'good with some concern'. The trend in condition is often uncertain due to limited data.

Integrity

The property demonstrates the interaction between people and the landscape over millennia and has an exceptional degree of intactness and high degree of naturalness. The property's large extent, remoteness and quality of wilderness, together with a comprehensive management plan, is the foundation for maintaining the integrity of its values and assessing the condition of integrity as 'good'.

Environmental Quality attributes assessment

	ASSESSMENT RATING			
	Good	Good with concern	Significant concern	Unsatisfactory
Wilderness		✓✓		
Viewfields		✓		
Water Quality	✓			
Air Quality	✓			
Aesthetics	✓			
Bank Erosion Lower Gordon River		✓✓		

The overall condition of wilderness value across the TWWHA remains 'good with some concern' with localised minor reductions in the wilderness value score over time.

Views of the dramatic and varied wilderness landscapes of the TWWHA remain largely intact. Fire, and increasing development pose the greatest threat.

Due to the remoteness of the streams, rivers and lakes of the TWWHA, the overall condition of water quality is thought to be 'good'.

The overall condition of air quality across the TWWHA is thought to be 'good' and considered to be the 'cleanest' in the world.

The overall condition assessment of aesthetic attributes of the TWWHA including litter, noise and dark skies is thought to be 'good'.

Bank erosion in the Lower Gordon River is assessed as 'good with some concern'. Levels of erosion have stabilised over time due to adaptive management of vessel speed and access.

Overall Environmental Quality Summary

Environmental Quality		✓✓		

The vast majority of the TWWHA is of very high to extremely high mapped wilderness quality. Air quality is naturally very good across the TWWHA and recognised as some of the 'cleanest' anywhere in the world. Bushfires can however temporarily increase particulate matter levels and the smoke can impact large areas both within and outside the property. The natural soundscape of the TWWHA is generally tranquil due to its remoteness from urban and industrial noise sources. Flotsam and jetsam litter from boats travels in long distance currents and ends up on the 300km of south-western coastline, requiring regular cleanup.

Habitat Condition assessment

Islands ? ◔

There are over 50 named islands and offshore rocks and thousands more unnamed smaller reefs and rocks protected within the TWWHA boundary. We only have limited historical monitoring on the condition of a few of these. However, it is expected that most of these island habitats remain in 'good' condition because of their isolation and absence of pests and weeds.

Coasts ◑

The south-west coast of the TWWHA remains one of the most exposed and least disturbed by human activity in Australia. This remoteness means limited human impact apart from walking tracks and associated infrastructure. However, the prevailing Great Southern Ocean current means that debris and rubbish is often washed ashore. Invasive plants can also take hold in this way. Recent volunteer efforts to remove infestations of sea spurge and marram grass have been successful. The beaches are exposed to the most energetic and stormy swell wave climate of any Australian coast and in some areas, climate driven changes in coastal dynamics have altered the beach structure. Globally unusual marsupial lawn vegetation fringing estuaries, creek outlets and fore-dunes have been eroded and removed in recent decades. Most sandy beaches on the south-west coast currently exhibit actively eroding dune fronts and have done so for at least the last few decades. Some dunes are affected by large sandblows. The condition of habitats of the coastal zone and its associated dunes is assessed as 'good with some concern' caused by continuing erosion, weeds and litter buildup.

Estuaries ◔

The TWWHA has three large estuarine systems (Gordon, Port Davey – Bathurst Harbour and New River) and many smaller ones. All are microtidal and prone to bank erosion due to sea level rise. Erosion of the lower Gordon River banks has been accelerated by the wave wake of river traffic, but that impact is lessening with imposition of management controls. The unique estuarine ecological community of Port Davey-Bathurst Harbour is thought to still be in good condition, but a lack of data precludes a definitive assessment. Overall, our assessment of estuarine habitat condition is classed as 'good with some concern' due to erosion and sea level rise.

Lakes ◔

There is little information about the condition of the lakes within the TWWHA, but what there is, coupled with their remoteness, suggests excellent water quality characteristics and likely healthy ecosystems. However, the presence of the introduced brown trout in some lakes restricts the distribution of native galaxias fish species and alters invertebrate community composition. Recent modelling of water temperature data collected from shallow lakes and wetlands of the Central Plateau suggests that they are at risk of drying out due to increasing air temperature in the coming decades. Our assessment of lake habitat condition is classed as 'good with some concern' due to climate change impacts and a lack of data.

Habitat Condition assessment (continued)

Rivers ? ◔

The majority of the rivers of the TWWHA remain virtually undisturbed by humans and are thought to be in very good condition. However, aside from the Gordon River, there has been little recent monitoring. In 2008 the Conservation of Freshwater Ecosystems Values approach was used to assess freshwater ecological values. The rivers of the TWWHA were assessed as being in near pristine condition but with some in good condition only. The presence of brown trout in some rivers restricts the distribution of native galaxias fish species and alters invertebrate community composition. Water flows in the Gordon and Huon Rivers have been altered by dams managed for hydro-electric power generation. River habitat condition is therefore assessed as 'good with some concern' due to introduced fish impacts and the presence of river regulation.

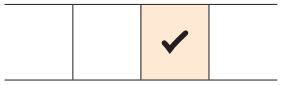
Caves ↔ ◑

About 119,000 ha or 7.5% of the TWWHA is underlain by karst rocks, including many large and otherwise exceptional karst caves. The condition of these cave systems remains very good in most cases, due to remoteness and low visitation. However more accessible caves on the periphery are subject to more frequent visitation and a few of these caves have experienced a loss of condition. Cave and karst habitat condition is therefore assessed as being 'good with some concern' due to visitation impacts.

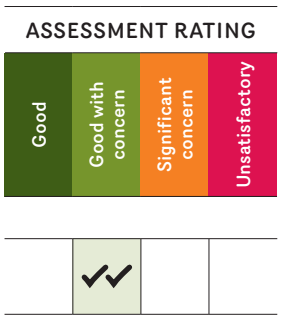
Moorlands and scrub ↔ ◔

Moorland and scrub vegetation are extensively distributed within the TWWHA and are highly variable in composition and structure. Most are in good condition. Some localised areas of buttongrass moorlands have become degraded by the introduced plant pathogen *Phytophthora cinnamomi*, which has reduced populations of many shrubs and forbs within affected areas. Moorland biota recover well from planned burning but the tolerable limits of fire frequency and intensity needed to maintain diversity are still not fully understood. There is a small risk that inappropriate fire regimes may degrade moorland condition slowly over time. Some loss of the organic components of soils and subsequent soil erosion caused by recent summer bushfires has occurred. Overall, Moorland habitat condition is assessed as 'good' due to its natural resilience.

Grasslands ↔ ◔



Grassland occurs on more fertile soils within the TWWHA, and most extensively on the Central Plateau. Some areas of grassland have been lost entirely or the species richness and composition has been depleted due to past overgrazing and frequent burning causing conversion to shrubland. It may be that the absence of fire for such a long period may mean that montane grasslands in the TWWHA never achieve the diversity that was historically documented or be as diverse as other montane grasslands with different fire histories in similar areas. Maintaining grassland condition depends on appropriate fire management. Due to the past loss of grassland, the current grassland habitat condition is assessed as 'significant concern'.



Alpine ⟷ ◕

The alpine habitats include numerous glacially-eroded peaks, ridges and the extensive Central Plateau. The condition of these areas varies from excellent in remote areas to degraded in the case of parts of the Central Plateau, due to a legacy of historic burning and grazing. Most alpine vegetation is still in good or very good condition however small areas have been impacted by recent fire events, resulting in localised losses in condition to very poor. Predicted climatic changes such as extreme heat events, warming temperatures and reduced summer rainfall are likely to result in further fires and may eventually reduce the area climatically suited to alpine vegetation. There is not yet evidence of an increase in the elevation of the treeline but an expansion of shrub cover has been observed in some alpine areas, including some snow patch communities. Because of the impacts from climate change, the current condition of alpine area habitats is classed as 'good with some concern'.

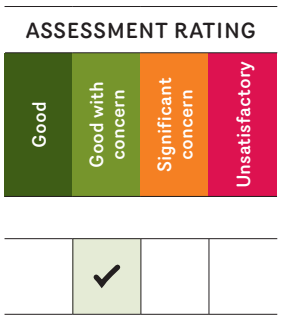
Rainforest ⟷ ◔

Rainforests, especially those in which the paleoendemic tree species including *Athrotaxis* species, *Lagarostrobos franklinii*, *Diselma archeri* and *Nothofagus gunnii* are prominent, are dependent on protection from bushfires for their conservation. Recent bushfires have caused the permanent loss in condition of close to 1% of these forests, with more than 6% of other rainforest habitats (including mixed forests) also impacted. Climate change is likely to increase the frequency, size and intensity of summer bushfires, which will cause further losses to the condition of rainforests in the TWWHA. In addition, die-back events in *Nothofagus gunnii* and rainforest conifers have been observed. Rainforest habitat condition is therefore classed as 'good with some concern'.

Eucalypt forest and woodlands ⟷ ◕

Most of the TWWHA eucalypt forests are dependent on infrequent fire events (at least one event every 300 years) for their perpetuation. Occasional fires in these communities do not result in a loss in their condition unless the frequency of fire events exceeds their capacity to reach mature stage mixed forest (eucalypt forests with an understorey of rainforest). There is currently no evidence that the rate of fires will prevent forests reaching maturity in the next century. However premature eucalypt senescence and extensive die back has been observed in various species. The cause is not clear in all cases but may be related to a lack of fire and/or stresses directly or indirectly associated with climate change. Giant trees and very tall forests are particularly vulnerable to climate change as the increased frequency of extreme heat events is predicted to dramatically reduce productivity in wet forests. Once the current very tall forests and giant trees are killed by bushfires it is likely that future climate will not suit their regeneration. Because of these impacts, the condition of eucalypt forest habitats is classed as 'good with some concern'.

Habitat Condition assessment (continued)



Soils ? ◔

Soil represents a massive and little understood habitat within the TWWHA. It hosts plants, animals such as burrowing vertebrates and invertebrates, fungi and microbes. It also sustains a large proportion of the food sources for all its inhabitants. Impacts on soil condition are mostly from fire which combusts the organic component of soils leading to other erosion processes. Other impacts come from human actions such as vehicular access, and damage from invasive feral animals such as deer and lyrebirds. The condition of most soils in the TWWHA has not been assessed, but across large areas is likely to be close to natural. However, significant degradation has occurred in isolated environments, including the Central Plateau where 11,000ha of eroded ground was mapped in the mid 1990s, and the southwest buttongrass moorlands. Areas of bare ground on the Central Plateau continue to erode at a slow rate. Small degraded areas impacted by human actions include coastal fringes, roads, walking tracks and campgrounds. Recent summer fires have continued to impact organic soil horizons. The projected trend of increased size and frequency of summer bushfires and a warming climate suggests further loss in soil condition is likely. Our assessment of soil habitat condition is therefore classed as 'good with some concern' primarily due to bushfire impacts.

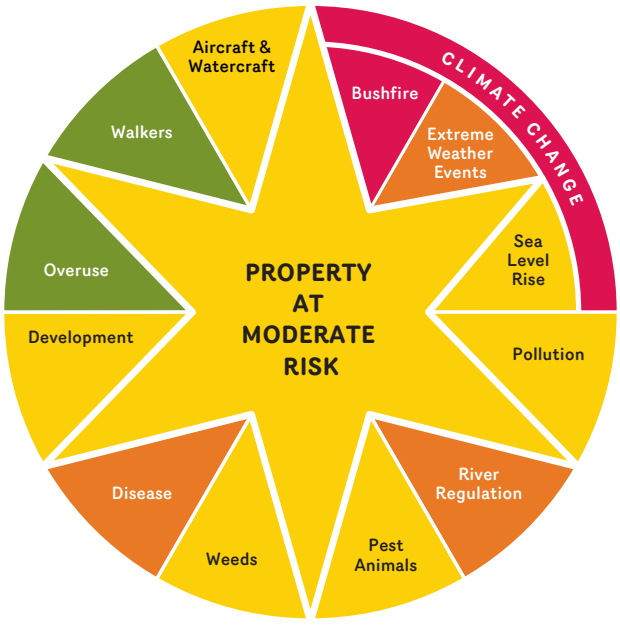
Overall Habitat Summary

TWWHA habitats support for species ↔ ◑

On the basis of current monitoring and knowledge, the bulk of habitats across the property remain in relatively good condition but with deterioration in condition in some habitats often associated with climate change driven impacts. Our overall habitat assessment rating is 'good with some concern'.

Threat Landscape Summary

In common with World Heritage listed properties around the world, the TWWHA faces a range of risks to its natural values. All are with us already but their risk severity rating is what is changing over time. If we were to jump forward 10 years, our assessment of the risk from threats might reveal a different picture. Some threats are operating at a very localised level, others across the entire property and others on very specific attributes. The biggest threats to the OUV of the property at present are related to climate change impacts, the most significant and immediate of which, is the increased frequency and intensity of bushfires that have been observed over the last decade. This change in the fire risk and resultant impacts is potentially also contributed to by other factors such as underlying vegetation fuel loads, however climate change is recognized as being the primary factor. The changing climate also brings with it a range of other threats which will impact the natural values of the property. Severe and rapid impacts are predicted to be catalyzed by extreme events of which bushfire is the most significant, but others may include, heatwaves, droughts, storm surges and floods. If the current trend of more intense and regular extreme events continues, permanent damage to some of the TWWHA's key attributes is inevitable.



THREAT LANDSCAPE ASSESSMENT

Increasing visitation also brings with it risks to the values of the property that will require careful management in order to ensure minimal impact to the particularly sensitive values of some of the unique environments of the TWWHA.

Biosecurity risks are well documented for both the past and the present and we can expect these to be with us into the future. Given the number of these pests, weeds and diseases we will need to remain vigilant. A focus on the biosecurity threats outside of the property and the development and implementation of a biosecurity strategy for the TWWHA will help to mitigate the serious risks posed to the fauna and flora of the property from incursions of disease and pests.

Similarly, the threats from land use changes outside of the property are already impacting around its edges and these impacts can be expected to continue into the future.

Many of the threats are well understood and many of the consequences could be significant to the property. As such, threat monitoring and preparedness for the future will be high on the agenda.

Wilderness

Threats to wilderness quality are most likely to occur from overflights, increasing visitor numbers, illegal access and activities, and development external to the property, as well as catastrophic bushfires that can change the landscape.

The threat to wilderness values of the TWWHA is considered to be major.

Water Quality

Turbidity issues arise from river bank erosion due to boat wave wake and following bushfires where increased runoff and erosion occurs. Nutrient enrichment caused by intensive salmon farming is also a threat.

The threat to water quality of the streams and rivers of the TWWHA is considered to be moderate.

Aesthetics

> **Air quality** – whilst bushfires generate a lot of smoke the prevailing winds rapidly disperse the smoke in an easterly direction away from the TWWHA.

> **Viewfield** – fire damage to the landscape in addition to increasing tourism infrastructure and visitor numbers, if not carefully managed, may erode the viewfield experience.

> **Soundscape** –visitation and overflight of aircraft is increasing with a resultant increase in noise levels.

> **Litter** – increasing visitation and illegal 4wd incursion brings with it a higher risk of littering.

The threat to aesthetic values of the TWWHA is considered to be moderate with increasing development, visitation, and illegal activity.

Vegetation

Phytophthora is already present across wide areas of the TWWHA impacting on vegetation. Myrtle rust has the potential to impact the eucalypt forests of the TWWHA. Illegal 4WD activities can destroy sensitive vegetation such as sphagnum. Intense bushfires can decimate large tracts of vegetation and in some cases vegetation that would normally not be considered at risk (eg rainforest) has been impacted.

The threat to the vegetation values of the TWWHA is considered to be major with the potential for some unique populations to be wiped out either by bushfire or disease.

Animals, Birds & Fish

Diseases continue to impact iconic species such as Orange bellied parrots, Tasmanian devils and wombats. The potential for loss of faunal species due to large and intense bushfires is considered high given the experience in 2019/20 on mainland Australia.

The threat to the fauna values of the TWWHA is considered to be severe with some species at significant risk from disease and bushfire.

Caves & Karst

Increasing tourism numbers in the show caves of the TWWHA has the potential to further erode delicate cave features. Bushfire smoke and heat can cause impacts in the cave entrance environment.

The threat to the cave and karst values of the TWWHA is considered to be moderate.

Beaches and dunes

Damage to the Central Plateau dunes is occurring due to driving, camping, and raised lake levels. Recent bushfires have also impacted dunes on the Central Plateau. Illegal activity along beaches and dune systems leads to erosion. Coastlines and associated dunes displaying evidence of shoreline erosion and sand blows as a result of changing climate.

The threat to the beaches and dunes of the TWWHA is considered to be moderate.

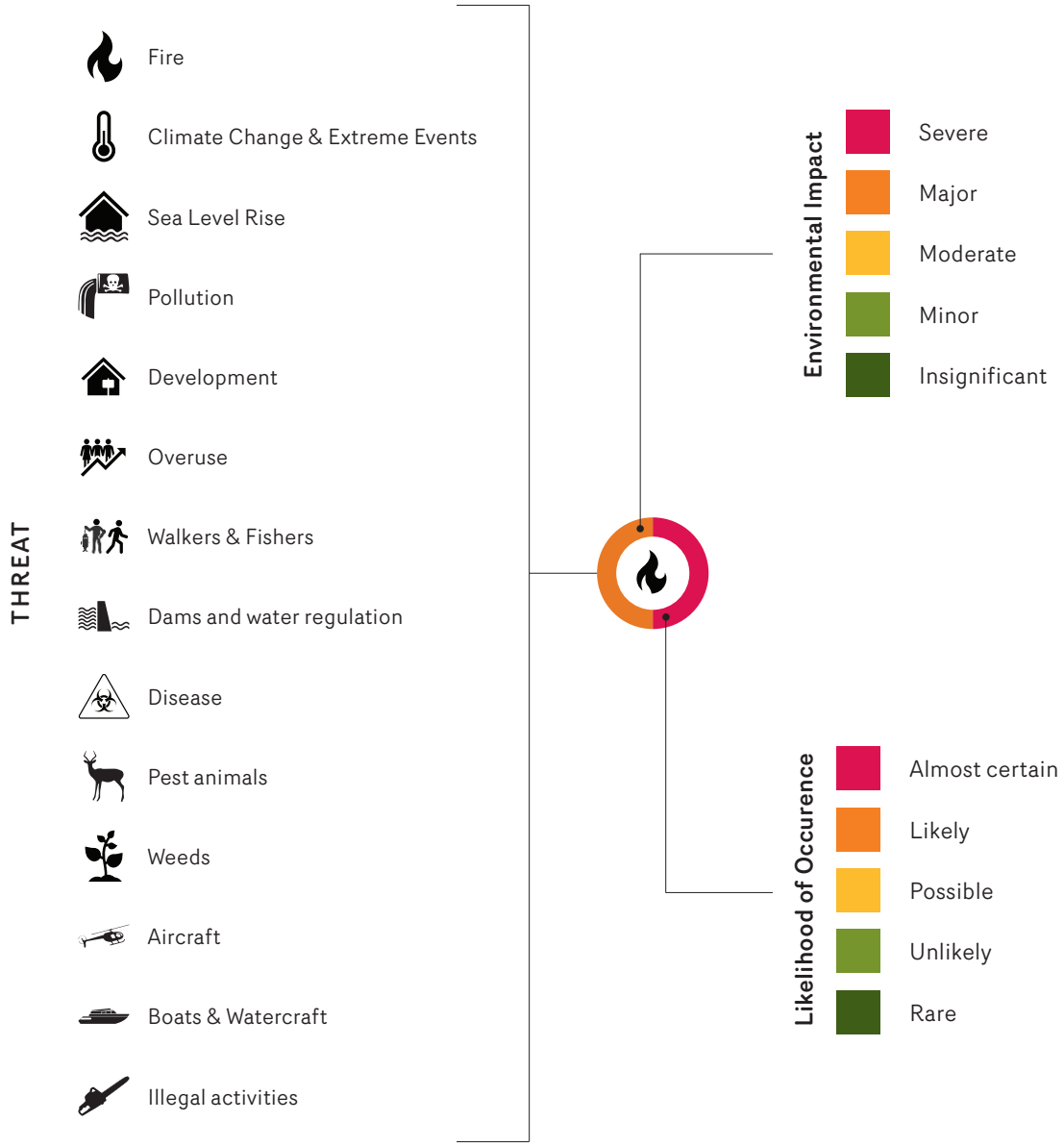
Soils

Bushfires are increasing in their frequency and intensity and already some areas of organosols have been incinerated exposing mineral earth. Climate change with a hotter, drier climate, will change organic soil accumulation rates across all soil types.

The threat to the soils of the TWWHA is considered to be major due to the increasing frequency and intensity of bushfire.

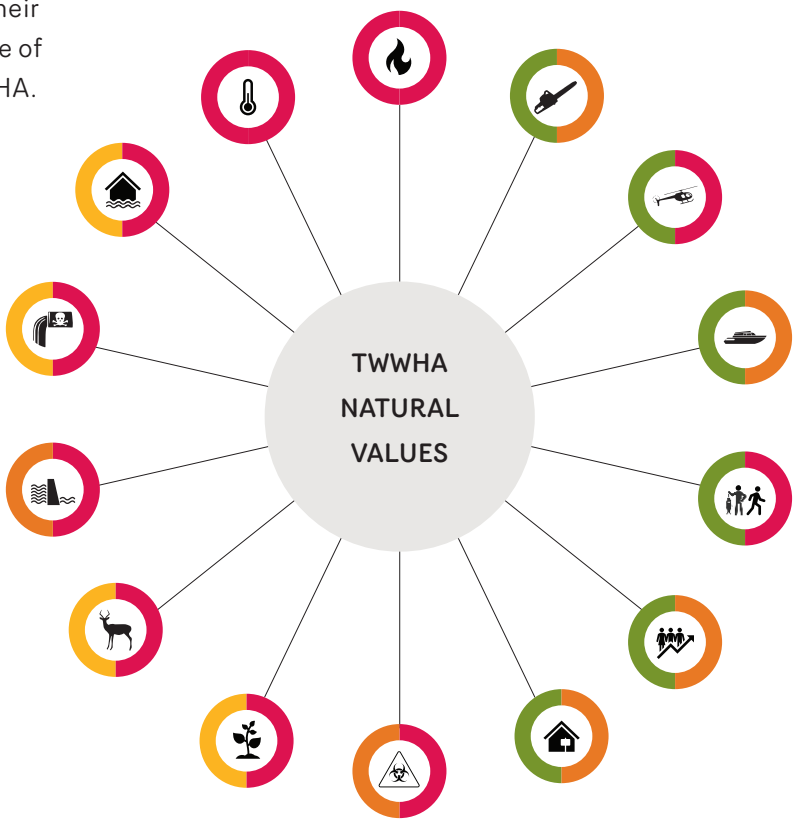
The threat rankings table provides one way of assessing threats. Another way is to use a commonly applied risk likelihood and consequence assessment to show how likely a risk is to occur and if it does, what consequence will it have. This provides an additional level of information, providing the reader with a more nuanced interpretation.

The following infographic displays each threat and its considered current likelihood and environmental impact consequence. Below is a guide to interpreting the infographic.



Current Threat Landscape impacting the natural values of the TWWHA

An indication of the key current threats, their likelihood of occurrence and consequence of impacts to the natural values of the TWWHA.



INSPECTING THE BURNT LANDSCAPE FOLLOWING THE 2013 GIBLIN VALLEY FIRE -

Photo: Tim Rudman

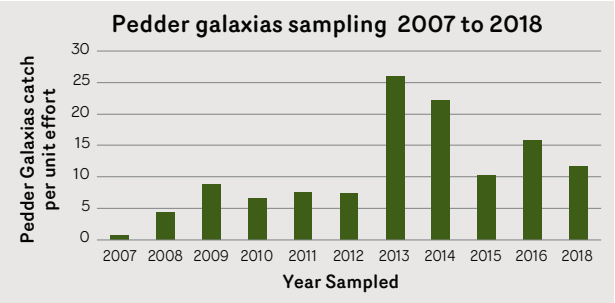
Condition and trends of natural values

Summary Snapshot

Overall, natural values, ecosystems and species diversity in the TWWHA have remained in good condition with some in excellent condition but we have some attributes showing concern. The TWWHA contains the world's most intact guild of medium-sized marsupial carnivores – the Tasmanian devil; the spotted-tailed quoll, and the eastern quoll. The TWWHA also contains three of the seven regional hotspots of plant endemism within Tasmania as well as fossils, refugial rainforest and relict biota with phylogenetic links to Gondwana. The TWWHA also contains about 80 per cent of Tasmania's sphagnum peatlands – a listed threatened community at both the state and national level.

The outstanding landscape wilderness quality which provides a proxy indicator of the undisturbed state of multiple natural values in the TWWHA has been maintained over the assessment period. Although minor losses in wilderness value occurred over this period, these have been balanced by comparable gains in wilderness value through extensions to the property that have also enhanced the integrity of the property, providing added protection for natural and cultural values. The property boundary extensions also allowed new and internationally significant natural values to be incorporated into the TWWHA including extensive areas of endemic conifers, alpine vegetation, giant flowering trees, sphagnum peatlands and limestone karst systems.

A number of degraded sites and values were also rehabilitated and/or restored as a result of active management interventions. For example, a project to eradicate the sea spurge weed along the southwest coastline of the TWWHA successfully treated all infested sites along a 600 km strip.



Translocation efforts to move the threatened endemic Lake Pedder galaxias fish to more protected and suitable habitat in Lake Oberon and Strathgordon water supply dam have been successful.

Elsewhere, maintaining the wild population of the critically endangered Orange-bellied Parrot continues to pose a challenge, with previous concerns for the persistence of this species in the wild. A highly successful captive breeding program has established a large insurance population allowing birds to be released to the wild annually and the latest bird returns to Melaleuca are the best for over a decade.

Numbers of Shy Albatross on Pedra Branca and Mewstone islands are in decline with commercial fishing and competition from gannets continuing to have an impact.

A 2009 survey of the waterways and lakes of the TWWHA showed 49%, or 495 of 1014, of all mapped lakes in the TWWHA > 1 ha in surface area remain trout-free. Data are unavailable for small lakes, tarns and ponds of surface area < 1 ha, but the proportion of tarns that are trout-free is believed to be high. Of the 49 lakes > 50 ha in size within the TWWHA, only 9 were shown to be trout-free at the time. Seventy three per cent of the total mapped stream length within the TWWHA was assessed as trout-free. Some 459,000 ha of the TWWHA's coastal river catchments, between Point Hibbs and South East Cape, remain trout-free.

An increase in frequency and intensity of bushfires over the last five years has led to loss and/or degradation in the condition of specific natural values in the TWWHA. Fires damaged small areas of fire-sensitive vegetation communities, including high conservation value ancient forests of endemic conifers and alpine vegetation communities.

The mainly pristine freshwater ecosystems of the TWWHA are considered to be highly vulnerable to the potential impacts of climate change. Warmer temperatures, increased wind and changing rainfall patterns are projected to impact water availability. Preliminary modelling under future climate change scenarios indicates that the >2000 shallow wetlands and seasonal wetlands on the Central Plateau are at most risk of habitat decline under the more intense climate change scenario. The primary risk is from partial to substantial or complete drying, while elevated maximum temperatures will also present a periodic stress risk to aquatic biota. Smaller (shallow) wetlands will be the first and the most intensely affected, though larger (deeper) wetlands will also eventually experience considerable seasonal contraction. Very deep wetlands such as Lake Louisa and Lake Meston on and around the Plateau, as well as larger more longitudinally connected wetlands, may be less affected and may provide significant local refuge for biota, particularly if they are seasonally thermally stratified.

Three small meromictic (permanently stratified) lakes adjacent to the lower Gordon River (Lake Morrison, Lake Fidler and Sulphide Pool) and their associated unique planktonic communities were impacted during the assessment period by hydrological modifications (including altered patterns and volumes of water flow) associated with hydro power generation operations on the Gordon River. The meromictic conditions once maintained by saline water intrusion, have been lost as freshwater releases from upstream have pushed the historical salt wedge that maintained meromixis, further downstream.

From top to bottom

A SPECTACULARLY COLOURED ORANGE-BELLIED PARROT *Photo: Timothy Rudman*

SHY ALBATROSS COMING IN TO LAND *Photo: NRE Tasmania*

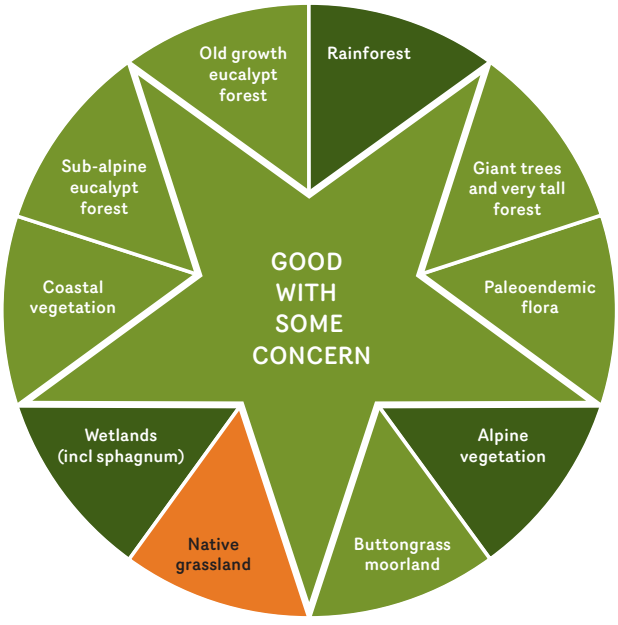
GELL RIVER FIRE, STRATHGORDON *Photo: Chris Emms*

CENTRAL HIGHLANDS LANDSCAPE WITH HUNDREDS OF SHALLOW WETLANDS AS FAR AS THE EYE CAN SEE *Photo: NRE Tasmania*

Vegetation Values

PANDANI AND CUSHION PLANTS DOMINATE THE ALPINE VEGETATION ON THE SIDE OF FRENCHMANS CAP - *Photo: Tim Rudman*

The condition of the native vegetation communities and species of the TWWHA is assessed as 'good with some concern'.



VEGETATION VALUES

The majority of vegetation communities remain in excellent condition, however native grassland areas have been impacted from historical grazing and the absence of fire for long periods. Fire in these grassland landscapes brings significant ecological benefits and so this reduction in fire return interval results in species richness and composition being reduced. Extreme bushfire events driven by climatic changes, and biosecurity risks such as phytophthora dieback, are currently the most significant threats to the flora of the TWWHA. As climate change progresses, extreme events including droughts and heatwaves in combination with the increasing bushfire threat, is likely to progressively damage and erode sensitive flora values. The PWS has instigated planned burning to maintain habitat and species richness in fire-dependent ecosystems of the TWWHA, with work at Melaleuca yielding good results and helping support the maintenance of populations of the critically endangered Orange-bellied Parrot.

Tasmania is one of Australia's hotspots of botanical diversity and endemism at the large regional scale. Throughout recent geological history, Tasmania has been an island off southeastern Australia and it's southerly position, variable topography, geology and soil types, have given rise to its highly diverse and significant vegetation. There is a strong gradient in precipitation and soil fertility from the southwest to the northeast of Tasmania. In the west, soils are poor and rainfall reaches in excess of 4000 mm per annum. In the east rainfall may be less than 400 mm per annum and the soils are often more fertile.

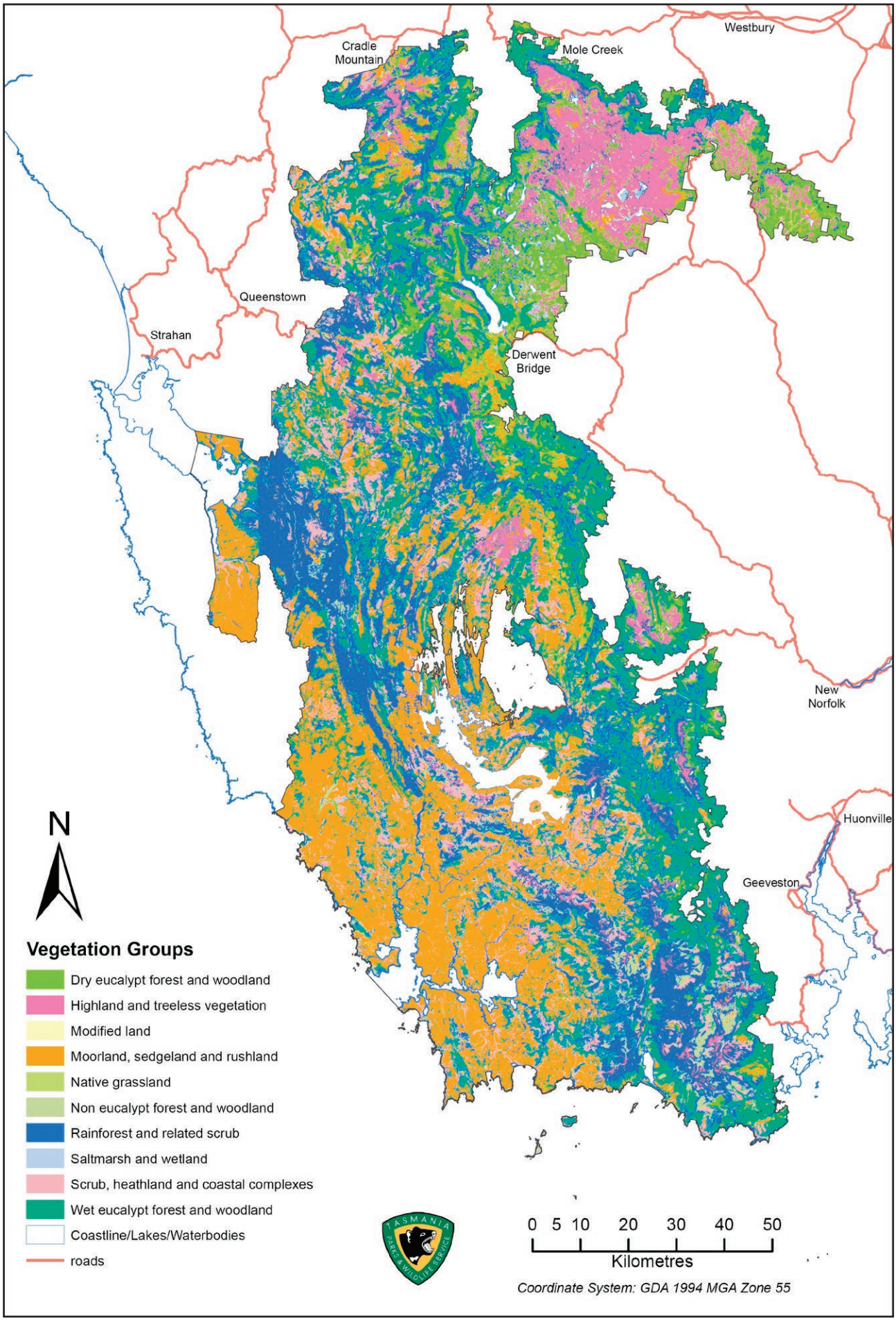
The TWWHA contains significant areas of natural habitat renowned for their plant diversity, species of ancient origins, high degree of endemism and the presence of many species of natural rarity. These qualities enable it to meet the World Heritage natural listing criterion (x).

The TWWHA provides a stronghold for Tasmania's palaeoendemic flora, extant members of ancient plant groups, once widely distributed and now with highly restricted distributions. This flora, which comprises about 50 Tasmanian endemic species, have their greatest abundance and richness levels in long undisturbed areas of rainforest and open habitats of high rainfall montane and subalpine areas. The montane rainforests and coniferous heaths of the TWWHA are internationally significant because of their richness in primitive taxa and affinity to the ancient flora of Gondwana. The conifers standout as the best examples of these primitive endemic taxa. Among the flowering plants, the most out-standing examples are several Tasmanian species that are now the last remaining extant members of their ancient genera. These include the delicate laurel, mountain rocket, the green mountain lily and the Tasmanian purple star, representing the ancient genera *Tetracarpaea*, *Bellendena*, *Campynema* and *Isophysis* respectively. These ancient genera originated between 57 and 80 million years ago and were once much more widespread.

From top to bottom

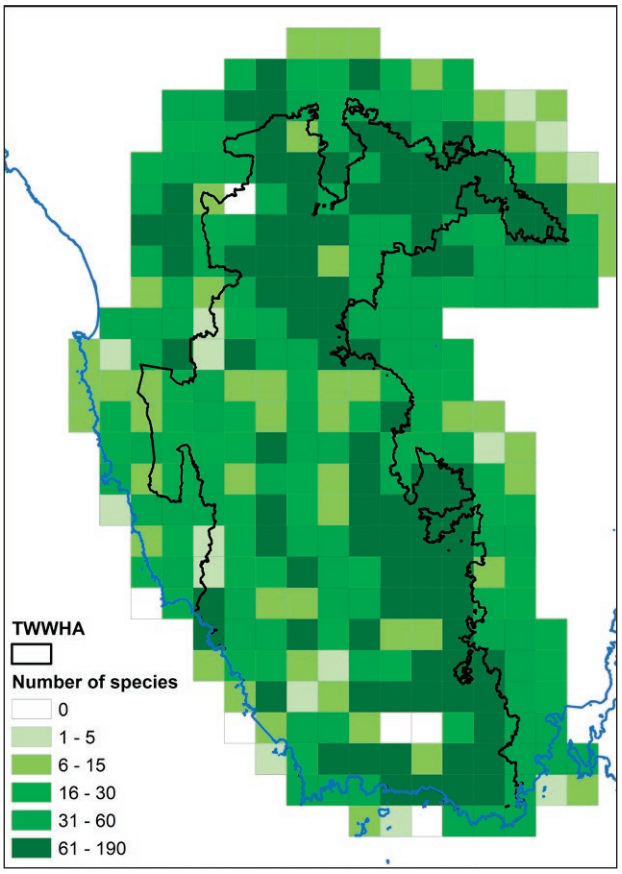
THE FLOWER OF THE GREEN MOUNTAIN LILY (CAMPYNEMA LINEARE), IS A STRIKING GREEN COLOUR, WHICH BLOOMS IN SUMMER - ***Photo: Micah Visoiu***

THE SPECTACULAR PURPLE SIX POINTED FLOWER OF ISOPHYSIS TASMANICA - ***Photo: Tim Rudman***


Cradle Mountain
Mole Creek
Westbury
Queenstown
Strahan
Derwent Bridge
New Norfolk
Huonville
Geeveston
N
Vegetation Groups
Dry eucalypt forest and woodland
Highland and treeless vegetation
Modified land
Moorland, sedgeland and rushland
Native grassland
Non eucalypt forest and woodland
Rainforest and related scrub
Saltmarsh and wetland
Scrub, heathland and coastal complexes
Wet eucalypt forest and woodland
Coastline/Lakes/Waterbodies
roads
TASMANIA PARKS & WILDLIFE SERVICE
0 5 10 20 30 40 50
Kilometres
Coordinate System: GDA 1994 MGA Zone 55

Unique and outstanding flora

Tasmania is one of Australia's hotspots for diversity and endemism within the vascular flora (flowering plants, conifers and ferns). The high number (richness) of vascular species restricted to Tasmania (i.e. endemic) can be explained by Tasmania's antiquity, southerly position, distinctive climate and geology (e.g. dolerite) and isolation from the Australian mainland. The diverse array of plant species and vegetation also reflects Tasmania's variable topography, soil types and microclimates.



ENDEMIC PLANT SPECIES RICHNESS BY 10x10km SQUARES

The TWWHA contains areas which have among the highest levels of plant endemism in Tasmania. The areas with the lowest recorded levels of endemism for the TWWHA (grid cells with 0 or 1-5 endemic species) are in remote, unroaded areas for which there still remains a dearth of survey data. The highest richness levels are associated with alpine and subalpine areas (e.g. Central Plateau, Mt Field NP, and southern and eastern mountain top areas). At least two thirds of Tasmania's vascular endemic plants can be found in these habitats. Other significant habitats for Tasmanian endemic plants include buttongrass moorlands, cool temperate rainforests and mixed forests (wet eucalypt forests with a rainforest understorey) which contribute to the high levels of endemism recorded for some of the lower elevation and montane areas of the TWWHA.

Among the Australian plant groups with high levels of endemism is the southern hemisphere heaths (formerly *Epacridaceae*). The TWWHA provides a significant conservation stronghold for this group with 61 species recorded (two thirds of those in Tasmania). Of these, 67% are endemic to Tasmania. Superlative examples of the evolution of this plant group include pandani (*Richea pandanifolia*), the tallest heath in the world and a common component of cool temperate rainforest. Another is the heath cushion plant (*Dracophyllum minimum*), which has evolved a hard bolster form. It closely resembles several other unrelated cushion species; the evolution of these species converging into a compact form well adapted to the harsh conditions of Tasmania's alpine zone, where ice bearing winds are common. Hard-leaved, woody plants (sclerophyllous), including members of the Epacridaceae, commonly dominate Tasmania's snow country. These alpine heathlands and cushion moorlands contrast strongly with the grassy, forb-rich plant communities of the mainland snow country, and demonstrate the important influence of low nutrient soils and maritime climate in the evolution of this distinctive vegetation.

The ancient conifers standout as the best examples of the primitive endemic taxa and are discussed separately.

A STAND OF MATURE PANDANI *(Richea pandanifolia)* DOMINATE THE MID LEVEL VEGETATION IN THE EUCALYPT FOREST AT LAKE DOBSON IN MT FIELD NATIONAL PARK
- Photo: Tim Rudman

From top to bottom

***Lomatia tasmanica* OR BETTER KNOWN AS KINGS HOLLY, BECAUSE OF ITS LIKENESS TO A HOLLY LEAF**
- Photo: Tim Rudman

SNOW COVERED LEAVES OF AUSTRALIA'S ONLY DECIDUOUS NATIVE TREE, DECIDUOUS BEECH *(Nothofagus gunnii)*
- Photo: Tim Rudman

The TWWHA is a population stronghold for fagus (*Nothofagus gunnii*) – Australia's only winter deciduous tree and a palaeoendemic species originating nearly 23 million years ago. Extensive tracts of riparian rain-forest also provide habitat for one of Australia's longest lived tree species – Huon pine (*Lagarostrobos franklinii*), a palaeoendemic species which evolved about 68 million years ago, with some trees shown to be more than 3000 years old. The ancient conifers including the Huon pine, standout as the best examples of the palaeoendemic taxa and are discussed in a separate snapshot.

Then we have the King's lomatia (*Lomatia tasmanica*), which is entirely restricted to the TWWHA and has been regenerating amongst an incredibly small and restricted population for more than 26,000 years. This is a unique example of a long-lived clonal plant.

The world's tallest hardwood tree species, mountain ash, *(Eucalyptus regnans)* has substantial populations within the tall wet eucalypt forests of the TWWHA. Giants over 85 m in height, form their densest stands amongst other very tall (> 70m) eucalypts, and together provide the best examples of Australia's mixed forest in which these giants tower above a well-developed cool temperate rainforest. This forest provides a superlative example of an ecological paradox in which the fire dependent – shade intolerant pioneer species (eucalypts) dominate over a mature shade-tolerant fire-sensitive vegetation (rainforest).

Vegetation matrices abound in the TWWHA where each plant community is dependent on a different fire regime for its perpetuation within the landscape. These vegetation mosaics demonstrate the complex ecological feedback systems between vegetation, environment and fire. As an example, extensive valley plains and slopes of fire dependent buttongrass moorlands are often adjacent to fire sensitive rainforests, but the rainforests are restricted to the areas topographically protected areas where fire rarely reach; and on the occasions when it does, the vegetation is usually too wet to burn. In contrast, the fire dependent buttongrass moorlands are among the most flammable vegetation in the world and can carry fire after only one or two rain free days.

Overall the TWWHA supports at least 54% of Tasmania's vascular flora (916 species), including 63% of the endemic flora (255 taxa) – about half of which are largely restricted to TWWHA and 27 of which have a very small ranges of less than 100 km. We know of 82 threatened plants including seven endemics that are listed nationally that are found within the TWWHA, four of which have all or most of their population within the TWWHA, so it remains an incredibly rich floristic landscape.

Palaeoendemic conifers and deciduous beech

The ancient conifer genera *Athrotaxis*, *Diselma*, *Lagarostrobos* and *Microcachrys* now have distributions that are entirely confined to Tasmania. The TWWHA provides the last remaining stronghold for the Tasmanian species of these palaeoendemic genera that came into existence between 37 and 150 million years ago.

In addition to the conifers, of similar importance we have the deciduous beech *(Nothofagus gunnii)*, an ancient flowering tree species that originated nearly 32 million years ago. Fossil evidence demonstrates that this species was present in Tasmania at about the time it originated (in the early Oligocene) suggesting it has persisted in Tasmania for much if not all of its existence. Like most of the palaeoendemic conifers it was once widespread, occurring as far away as South America but it is now restricted to Tasmania where it occurs only in fire protected habitats in high rainfall areas. It commonly occurs together with *Athrotaxis* species.

Athrotaxis originated approximately 150 million years ago and now has only two species still in existence – the King Billy pine *(A. selaginoides)* and the pencil pine *(A. cupressoides)*. While these species split off from other members of the genus relatively recently (in the last few million years), they provide the only genetic links back to this ancient plant group. Fossils of this genus have been found as far away as South America and have been found in Tasmania as far back as the early Eocene.

Trees of both *Athrotaxis* species can reach ages in excess of 1000 years, but Huon pine *(Lagarostrobos franklinii)* may reach ages of more than 3000 years. Both the pencil pine and Huon pine regularly reproduce clonally so that not only do the individual trees live for a long time but the clonal organisms may survive for many thousands of years. The genus *Lagarostrobos* is about 68 million years old. It is a genus and species that provides an excellent example of stasis, evolving and changing little over many millennia.

Only one of the palaeoendemic conifer species is listed as rare in threatened species lists — the Mount Mawson pine *(Phaerosphaera hookeriana)*, but recent surveys for this species have discovered it to be more widespread and common than previously reported. The primary habitat for Mount Mawson pine and two of the other palaeoendemic conifers, creeping pine *(Microcachrys tetragona)* and dwarf pine *(Diselma archeri)* is coniferous heathland. Within Tasmania, coniferous heathlands are largely confined to the alpine and subalpine areas of the TWWHA where they have an estimated area of 4560 ha. Fire is the major threat to these communities and they are now restricted to the parts of the landscape that provide natural protection from fire.

From top to bottom

***Diselma archeri* OR DWARF PINE, GROWING IN THE HIGH RAINFALL ALPINE REGIONS OF THE TWWHA IS VERY FIRE SENSITIVE** - *Photo: Tim Rudman*

THE RED FRUITS OF THE CREEPING STRAWBERRY PINE *(Microcachrys tetragona)* RESEMBLE RASPBERRIES. THE CREEPING STRAWBERRY PINE IS EXTREMELY FIRE SENSITIVE - *Photo: Tim Rudman*

FOLIAGE OF THE HUON PINE *(Lagarostrobos franklinii)*. THE HUON PINE CAN GROW TO AN AGE IN EXCESS OF 3000 YEARS - *Photo: Tim Rudman*

A LARGE PENCIL PINE WITH 3 MAIN UPRIGHT BRANCHES IN THE WALLS OF JERUSALEM NATIONAL PARK
- Photo: Nick Fitzgerald

Whilst the Mount Mawson pine might be listed as threatened, the only Tasmanian plant communities dominated by conifers listed as threatened are those dominated by *Athrotaxis* species. Recently refined high resolution vegetation mapping for *Athrotaxis* and deciduous beech communities in the TWWHA now estimate that King Billy pine rainforest and scrub communities cover some 17 000 ha, pencil pine rainforest and open woodlands cover 8 400 ha and deciduous beech com-munities in which *Athrotaxis* is sparse or absent cover 1 715ha of the TWWHA. This more accurate mapping will enable managers to more effectively target fire prevention and fire suppression efforts for the conservation of these rare and unique species.

Mapping of Huon pine rainforest and scrub cover is less accurate but our best estimate is about 9,200ha across the TWWHA. A project to investigate methods for detecting and mapping Huon pine more accurately is currently underway.

World Heritage listing has removed the past threats to these species, and fires have so far impacted only about 18 ha of King Billy pine habitat and 9 ha of densely populated pencil pine rainforest and 80 ha of more sparsely populated pencil pine open woodland. Although 190 ha mapped as Huon pine rainforest and scrub in the TWWHA are in areas which have burnt since 1982, ground surveys suggest that in many cases the Huon pine trees themselves have escaped damage. Huon pine is water dispersed and able to recolonise disturbed areas from upstream populations, so impacts of past disturbance (both logging and bushfires) have not resulted in the permanent loss, with most recovering slowly. In contrast, Athrotaxis trees and deciduous beech trees are usually killed by fire and take many centuries, if ever, to disperse back into these areas once burnt. Such burnt areas will recover but to another form of rainforest over the following decades or centuries. Once burnt the condition of these areas is considered permanently degraded by the loss of *Athrotaxis* and/or deciduous beech.

With bushfire being the major threat to these conifers, we know that lightning ignited bushfires are predicted to become more frequent and severe as part of global climate change. We also know that these lightning ignitions have been the cause of unplanned bushfires in the TWWHA in the past two decades. The drying climate and heat events are also likely to cause stresses on these conifer species leading to a reduction in their condition. A system for monitoring and tracking impacts by bushfires has commenced, and condition monitoring plots established in 2011, will form a baseline for future surveys. New methods of fire prevention, detection and fire suppression are also currently being trialed and an example of this is the deployment of sprinkler lines for the first time at Lake Rhona that helped prevent the loss of remnant conifers during the 2019 bushfires. The PWS is also now investing in remote winching capability, and satellite detection of ignitions, to respond rapidly and prioritise protection of these important values. Projects are also underway to collect and store seeds from *Athrotaxis* and other conifer species across their range so that in the event of future fires, these seeds may be used to assist in population recovery. Collectively it is hoped that these and other future management actions will ensure the conservation of these fire sensitive palaeoendemic conifers.

Snapshot – Giant Trees

Very tall forest and giant tree values in the TWWHA were enhanced by the 2013 extension of the property to include tracts of wet eucalypt forest on the eastern border of the TWWHA. Approximately 6 300 ha of very tall forest exceeding 70 m in height have been mapped using lidar technology. Areas with a high density of trees exceeding 70 m include Coles Creek and Gordon Range in the northern Florentine Valley area; Gee Creek, Andromeda Creek and south-east of Marriots Lookout in the Styx Valley. The greatest extent of > 70 m high forest is in the Gordon Range area with more than 1 000 ha including 770 ha in a single patch of very tall old growth forest.

Very tall eucalypt forests are centered on the high rainfall cool temperate forests of South-East Australia where six of the tallest eucalypt species occur. In Tasmania, *Eucalyptus delegatensis*, known as gum-top stringy bark, forms very tall forests at higher elevations on the Great Western Tiers and southeast of Lake St. Clair. At lower elevations, *E. regnans*, known as swamp gum or mountain ash, and *E. obliqua*, known as stringy bark, form very tall forests. Closely growing giant *E. regnans* form forest stands of exceptional height with the most phenomenal example of very tall hardwood forest in the world being the 'Andromeda stand' in the Styx Valley. This forest stand contains ten of the 24 tallest eucalypts known and eight of the ten tallest trees in the TWWHA. The tallest living current hardwood tree known in the world, and the second tallest of all known hardwood trees in the world, Centurion, reaches 100.5 metres into the sky. Centurion is a member of the species *E. regnans*, which is among a small number of eucalypts that are fire sensitive, with about a 50 per cent survival rate when exposed to bushfires.

The TWWHA now encapsulates the greatest representation of giant eucalyptus trees exceeding 85 m in height including the majority of the tallest eucalypts known. Very tall eucalypt forests such as exists in the pristine upper McLeod's

From top to bottom

THE GIANT EUCALYPT "CENTURION" REACHES FOR THE SKY, STANDING 100.5M TALL AND IS THE WORLD'S SECOND TALLEST FLOWERING PLANT - ***Photo: Kyle Rickard***

AERIAL VIEW OF THE STANDS OF VERY TALL FOREST FORMED BY EUCALYPTUS REGNANS IN THE COLES CREEK AREA OF THE FLORENTINE - ***Photo: Micah Visoiu***

Creek catchment, are un-matched elsewhere in extent and integrity. The wide distribution of the values across the property, undisturbed nature of many of the very tall forests, and the range in forest ages enhances the potential for ongoing retention of giant tree and tall forest values within the ecological dynamic of this fire driven ecosystem. Though there are risks for maintenance of gigantism values, the TWWHA provides the stronghold and most secure representation of giant angiosperm trees and very tall eucalypt forests in the world, helping maintain its OUV.

Snapshot – the 2019 fire in the tall eucalypt forests of Warra

Periodic bushfires have shaped Tasmania's tall eucalypt forest landscapes. Unlike the bushfires in tall eucalypt forests on mainland Australia, those in Tasmania often burn less intensely.

This lower fire intensity results in forests containing trees of two, or more, ages – multi-age forests. While multi-agedness predominates in Tasmania's tall eucalypt forests, we have little knowledge of the attributes of fires that help maintain multi-agedness.

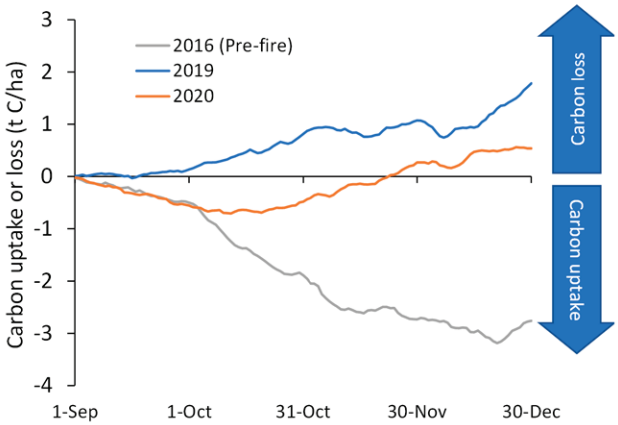
In January and February 2019, the Riveaux Road Fire burnt 64 000 ha of tall eucalypt forest, moorland and plantations in the Huon Valley over a three-week period. The western portion of the Riveaux Road fire burnt in the TWWHA, including the Warra Supersite – part of the Terrestrial Ecosystem Research Network (TERN).

Instruments at the Warra Supersite and a network of 1-hectare TERN plots measured conditions, before, during and after the 2019 fire and provided a record of how the forest changed. For the first time we had the chance to measure a fire in unprecedented detail.

Weather conditions over the three weeks the fire was burning were mild. This meant the Forest Fire Danger Index stayed mostly in the moderate range. Reflecting this, the fire burnt mostly at low intensity through the Supersite: air temperatures beneath the forest canopy did not exceed 70°C.

The fire consumed ground litter, and ground vegetation and scorched the understorey trees. Most of the understorey trees and shrubs that were scorched by the fire subsequently died. The *Eucalyptus obliqua* overstorey was largely unaffected by the fire except for localised crown scorching, usually where there were openings in the forest canopy. Prolific germination of seedlings occurred in the first year after the fire: surveys of four TERN plots measured 450 000 seedlings per hectare.

Prior to the fire, the forest at Warra was a carbon sink: the forest gained 2-3 tonnes carbon per hectare, during the spring and early-summer period when productivity is at a maximum. In the two years after the fire, the forest became a carbon source during the spring and early-summer period, losing 1-2 tonnes carbon per hectare. How long the forest remains a carbon source is unknown – that will be a focus of ongoing monitoring at the Warra Supersite.



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THE 80M HIGH WARRA FLUX TOWER LOOKS DOWN UPON THE CROWNS OF THE EUCALYPT FOREST AT WARRA. WARRA IS A RESEARRCH SITE UNDER THE TERRESTRIAL ECOLOGY RESEARCH NETWORK (TERN). THE PHOTO WAS TAKEN 18 MONTHS AFTER THE JANUARY 2019 FIRES. FERN REGROWTH IS VERY EVIDENT IN THE FOREGROUND. THE EUCALYPT TREE CROWNS REMAIN HEALTHY, WHILST THE MID STOREY STILL APPEARS BURNT AND NOT YET RECOVERING - ***Photo: Tim Wardlaw***

Rehabilitation of Fire Damaged Values

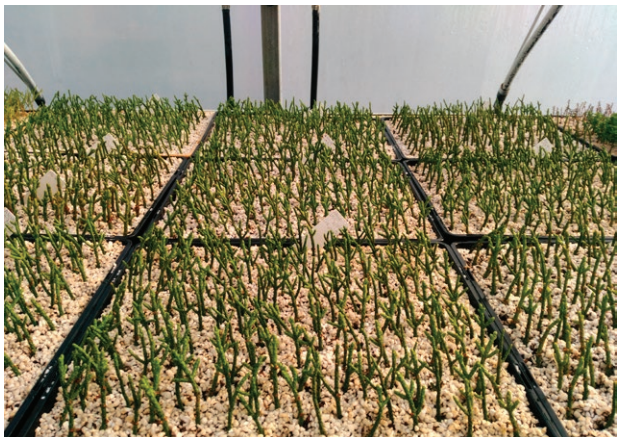
In January and February 2016 a bushfire that originated from an unprecedented lightning storm resulted in an extensive area being burnt across the state, including approximately 19 800 hectares of the TWWHA. Loss of fire sensitive vegetation contributing to the OUV of the property occurred, mostly in the Lake Bill, February Plains and Lake Mackenzie areas. Approximately 85 ha of pencil pine woodland and 79 ha of sphagnum peatland were burnt. A far larger area of soil was severely burnt, leaving it vulnerable to erosion.

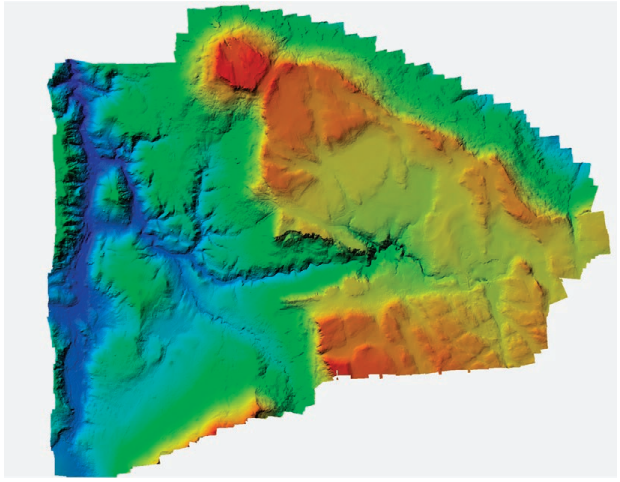
We know that the risk of fire to fire sensitive alpine vegetation and soils across Tasmania is expected to increase with climate change.

Research into rehabilitation trials in the impacted area has commenced with the objective to test methods to promote recovery, and/or maintenance of pencil pine and sphagnum community values, where these have been damaged by fire and mitigate long term erosion risks in high elevation fire damaged soils.

Research by Natural Resources and Environment, Tasmania and the University of Tasmania is well under way to develop and trial methods for rehabilitation of pencil pine stands, sphagnum peatlands and erodible soils in bushfire affected areas. The University researchers have 4000 pencil pine seedlings that will be used in the rehabilitation trials and have conducted aerial surveys of the affected area to produce a high resolution (34 cm per pixel resolution) digital elevation model on the impacted area as well as a super high resolution (2 cm per pixel) digital elevation model (DEM) of the study site within the impacted area.

The analysis of the trials will deliver a decision tool or guide to identifying conditions where the application of identified effective rehabilitation methods may be successful on fire sensitive alpine vegetation and soils in the TWWHA and will assist with mitigating future fire impacts on the OUV of the property and inform adaptive measures that will be required to manage climate change impacts on alpine environments within the TWWHA in the future. The techniques investigated by the rehabilitation trials may also assist management of runoff and erosion resulting from alpine fires within Tasmania's dam catchments.





From top to bottom

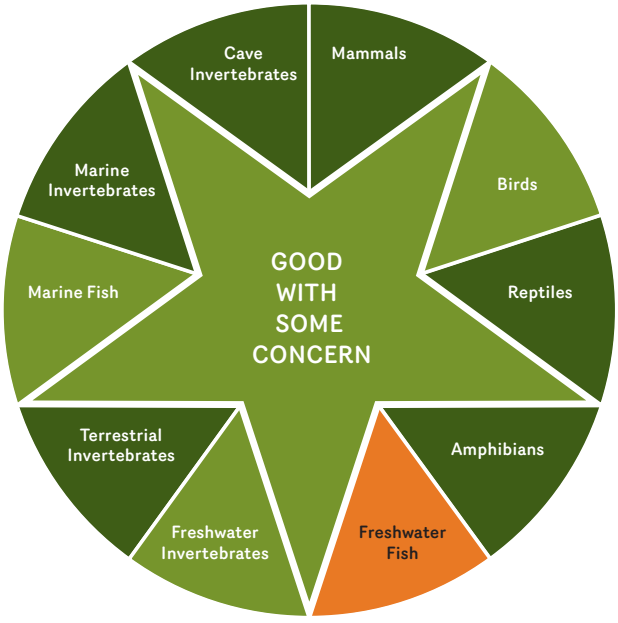
TRAYS OF SEEDLING PENCIL PINES BEING GROWN AS PART OF A REHABILITATION TRIAL FOR THE BURNT LAKE MACKENZIE AREA *- Photo: Herb Staubmann*

FIRE DAMAGED BROWN PENCIL PINE AS WELL AS UNTOUCHED BRIGHT GREEN PENCIL PINE VEGETATION AT LAKE MACKENZIE AFTER THE 2016 FIRES *- Photo: Chris Emms*

DIGITAL ELEVATION MODEL CONSTRUCTED FROM HIGH RESOLUTION PHOTOGRAPHY FLOWN BY A UAV OVER THE STUDY AREA AT LAKE MACKENZIE

Faunal Values

The condition of fauna of the TWWHA is assessed as 'good with some concern'. The majority of species remain unimpacted and in excellent condition. Bushfires, invasive species and disease continue to pose the most immediate and serious threats.



FAUNAL VALUES

The TWWHA plays a central role in the conservation of Tasmania's unique fauna, providing habitat for thriving animal populations, which are more protected there than elsewhere in Tasmania. At 1.58 million hectares of wilderness, the TWWHA provides a large and contiguous area for natural processes to occur. Several World Heritage fauna values were well documented when the property was first listed. Since then, inventories have been completed for vertebrate fauna in 2003 and invertebrate fauna in 2005 and these inventories identified the significant role that the TWWHA makes towards the conservation of Tasmania's fauna and natural biological processes.

The TWWHA supports 75 per cent (187 species) of Tasmania's terrestrial vertebrate fauna. This comprises 30 species of terrestrial mammal (90 per cent of total Tasmanian species) including five Tasmanian endemics, 120 species of terrestrial bird (75 per cent of state total) including 10 endemics, 14 species of reptile (67 per cent of state total) including seven endemics, seven species of frog (64 per cent of state total) including three endemics, and 16 species of freshwater fish (64 per cent of state total) including four endemics. The TWWHA also supports at least 68 species of marine fish (14 per cent of state total) including one endemic species.

Several vertebrate species (moss froglet, Pedra Branca skink, mountain skink, Lake Pedder galaxias, swamp galaxias, and western paragalaxias) are entirely restricted to the TWWHA while the migratory Orange-bellied Parrot breeds only within the TWWHA. A number of other species have the majority of their Tasmanian range within the TWWHA (e.g. broad-toothed rat, ground parrot, southern emu-wren, Tasmanian tree frog, northern snow skink, southern snow skink, Clarence galaxias and the Maugean skate).

There are significant breeding populations of seabirds on remote islands off the south-west coast, including two of only three breeding colonies (72 per cent of breeding population) of the threatened and endemic Shy Albatross. There are approximately five million other seabirds, dominated in number by short-tailed shearwaters and fairy prions. The islands are also important breeding sites for little penguins and two threatened species of seal: the long-nosed fur seal and the southern elephant seal.

THE ENDANGERED PTUNNARRA BROWN BUTTERFLY IS RESTRICTED TO POA GRASSLANDS OF THE CENTRAL PLATEAU
- Photo: Jo Potter-Craven

Invertebrates are the most diverse group of organisms in the TWWHA and contribute substantially to the World Heritage faunal values of the area. Although poorly understood, they help provide a detailed record of the processes of continental drift and climate change that have shaped the western half of Tasmania. The known invertebrate fauna of the TWWHA is characterised by very high levels of species that are endemic to Tasmania (46.7 per cent of species only found in Tasmania), a high proportion of species with a predominantly western-Tasmanian distribution, and numerous species with a restricted geographical range. Apart from the now ubiquitous bumble bee and European wasp, the latter posing a threat to the Ptunnarra brown butterfly in the Central Plateau area of the property, our expectation is that invasive species and disease will remain a relatively low risk to the terrestrial invertebrates of the TWWHA.

The marine invertebrates of the TWWHA are like terrestrial invertebrates, poorly understood, but with largely undisturbed marine and estuarine habitats, they are likely to be in good condition despite the occurrence of some invasive species and potential nutrient impacts from fish farms in adjacent waters of Macquarie Harbour. To date, the limited data we have available suggests that in the marine environments of the TWWHA, introduced species are yet to pose a significant threat, although further monitoring is required to confirm this.

The integrity and size of the TWWHA helps ensure habitat disturbance is not an issue, and with a secure habitat we expect that the vast majority of invertebrates of the TWWHA will continue to thrive both on land and in water.

Several types of fauna in the TWWHA are closely related to species found in other land masses that were once part of Gondwana. The mountain shrimp is regarded as a living fossil because it is very similar to 230-million-year-old Triassic fossils; it has close relatives in New Zealand and South America. The Tasmanian cave spider is one of the world's most primitive spiders, and is the only member of its family *(Austrochilidae)* outside Chile. There are many other unique species of invertebrates with Gondwanan links, including caddisflies, dragonflies, stoneflies and isopods.

From top to bottom

A BLACK CAVE SPIDER HANGING FROM THE LIMESTONE CEILING OF A CAVE - ***Photo: Rolan Eberhard***

AN ENDANGERED MAUGEAN SKATE SITS ON THE BOTTOM OF MACQUARIE HARBOUR - ***Photo: Neville Barrett***

Rare and Threatened

The TWWHA provides important habitat for many vertebrate and invertebrates species listed as rare or threatened under Tasmanian and Australian legislation, many of which are of exceptional value from a point of science or conservation (e.g. carnivorous marsupials, galaxiid fish, Maugean skate and Hickman's allanaspides). Most of these species are subject to threats outside of the property, which provides secure habitat.

The unique and rare Maugean skate, a resident of both Macquarie Harbour and Bathurst Harbour, and one of the largest predatory fish species in Tasmania, remains threatened. It has not been sighted in Bathurst Harbour for the last 30 years, and whilst research is underway to better understand its ecology threats, these fish remain

poorly understood. It is probably now restricted to a single estuarine system, being Macquarie Harbour, part of which is in the TWWHA, where it may be under threat from nearby fish farming activities.

Our efforts at translocation into the Strathgordon water supply dam and Lake Oberon to secure the population in the wild of the near extinct Pedder galaxias fish, whilst successful, highlight the threats posed to many of the rare and endangered fish species of the property. Distributions of other threatened galaxias in the wetlands of the property are also now limited by the presence of brown trout.

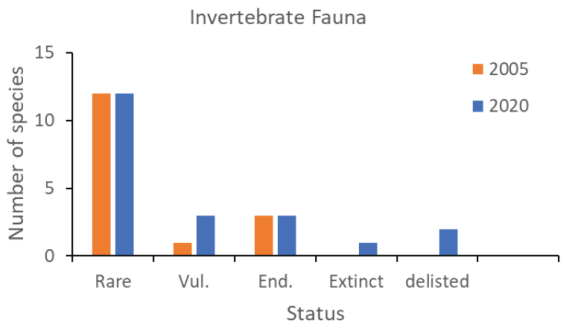
The size and integrity of the property, whilst affording a high level of protection to the majority of fauna, has not prevented some threats from developing. Frog chytrid disease is known to be present but has not spread into large parts of the TWWHA. Research suggests the conditions in the TWWHA are restricting the concentrations of chytrid zoo-spores and thus infections in our endemic frog species. In the freshwaters of the property, the presence of brown trout in 25 per cent of streams has had a negative impact on both freshwater fish and freshwater invertebrates. The southwestern streams, wetlands and lakes that are trout free have particular conservation value and provide an environment for fish and invertebrates where natural processes can occur.

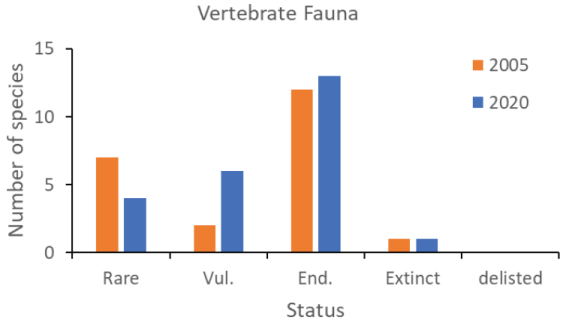
The TWWHA is a refuge for a wide range of rare and threatened species, including our carnivorous marsupials: the Tasmanian devil, the world's largest carnivorous marsupial; the spotted-tailed quoll; and the eastern quoll. Two of only five surviving species of monotreme, the most primitive mammal group in the world, are found in the TWWHA: the platypus and the short-beaked echidna. There are also more than 30 rare and threatened fauna species, including the Pedder galaxias fish, the Pedra Branca skink and the endangered Orange-bellied Parrot, which breeds only at the remote Melaleuca area.

The Tasmanian Threatened Species Protection Act (TSPA) was proclaimed in 1995 and protection within the TWWHA was an important consideration in assessing whether to list species as rare or threatened on the schedules of this Act. Many naturally rare species were not listed because they were well-protected in the TWWHA.

In 2005 when the inventories of TWWHA fauna were completed, there were 22 species of vertebrate fauna and 16 species of invertebrate fauna listed as rare, vulnerable, endangered or extinct on the TSPA.

In 2020 the number of listed species has increased to 24 vertebrates and 19 invertebrates. Most of the invertebrate species are considered to be naturally rare and at risk from stochastic events. Most vertebrates in the TWWHA are listed as endangered, with threats to the species mostly occurring outside of the TWWHA. Since 2020, two invertebrate species have been delisted because they have been found to be more widespread (the broad-striped ghost moth, and the caddisfly) and one (the Lake Pedder earthworm) has been declared extinct. Four invertebrate species have been added since 2005 because the 2013 TWWHA extension now includes the range of these species. The Tasmanian devil and its tapeworm have been added to the list of endangered species due to the risk posed by devil facial tumour disease, although large parts of the TWWHA remain free of the disease. The white-bellied sea eagle has also been added to the list because of pressures outside the TWWHA. Two vertebrate species, the eastern quoll and the hooded plover are listed nationally but not in Tasmania, where the TWWHA provides secure habitat. The high level of protection afforded the TWWHA makes the area very important for long-term fauna conservation in Tasmania.





ORANGE-BELLIED PARROT

Photo: David Watts

Photo: Simon de Salis

Snapshot – Orange-bellied Parrot

The Orange-bellied Parrot (OBP; *Neophema chrysogaster*) is listed as 'Critically Endangered' under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*, and is also listed as a threatened species in Tasmania, New South Wales, South Australia, and Victoria. With about 70 of these rare and beautiful birds left in the wild, the OBP is one of the most threatened birds in Australia.

Every year OBPs undertake an extraordinary journey, migrating across the Bass Strait twice – in autumn they fly to coastal mainland southeast Australia to over-winter, and in spring they return to Melaleuca in the south-west part of the TWWHA, to breed over the summer. By April each year, the OBP population departs the breeding grounds and migrates north along the west coast of Tasmania. Observations suggest that the passage across Bass Strait is undertaken by island hopping through the western Bass Strait Islands (e.g. Robbins, Perkins, Montague, Hunter and King Islands). Individuals are known to feed for many days or even weeks at some sites. Sea Elephant River (King Island) is a critical habitat for the species with as many as 20 individuals feeding on saltmarsh during March–May.

The Tasmanian Government has established a successful captive breeding program over several years to ensure the species does not go extinct, that has now grown to be in excess of 500 individuals. Despite this captive breeding initiative, the species remains at risk of extinction in the wild.

The wild population, which is measured at the start of each breeding season, was less than 35 birds between 2010 and 2019 but in January 2022 there are now 70 wild adult OBPs returning to the only breeding site at Melaleuca Lagoon in the far south-west corner of the TWWHA. We also released 24 captive-bred adult birds at Melaleuca in spring 2021 to increase the number of breeding pairs, and a further 50 captive-bred juveniles at the end of the season in March 2022 to increase the size of the migrating flock.

Current knowledge suggests that habitat loss and degradation, particularly in the non-breeding range, caused the initial decline in OBP numbers. OBPs may also be at risk from climate change, and the small population size places the species at increased risk from factors such as loss of genetic diversity and inbreeding, environmental events, predators and competitors, disease, and barriers to migration and movement.

Most known breeding activity occurs within 10 km of Melaleuca Lagoon. The birds nest in natural tree hollows that have also been supplemented by man-made nest-boxes in Eucalypt forest and rainforest adjacent to moorland and sedgeland plains.

At Melaleuca, where the birds forage for feed in the buttongrass moorlands, the PWS has commenced a program of planned burns to enhance OBP habitat. The planned burning is paying off, with OBP food plants now abundant in the regenerating burn area near the current breeding site and OBPs recorded numerous times foraging in the regenerating burn area.

There is still a long way to go for the Orange-bellied Parrot to have a viable self-sustaining wild population, but the 2021/22 season's results are a long-awaited big step in the right direction. Couple this with a rapidly growing captive-bred population, released birds increasing the size of the wild population, and availability of productive feeding habitat at Melaleuca, we are hopeful for continued good results in this and future breeding seasons.

Snapshot – Wedge-tailed Eagles

Two eagle species occur in the TWWHA and both are listed on the schedules of the Tasmanian Threatened Species Protection Act 1995. The white-bellied sea eagle *(Haliaeetus leucogaster)* is listed as Vulnerable and the Tasmanian wedge-tailed eagle *(Aquila audax fleayi)* is listed as Endangered. The wedge-tailed eagle is also listed as Endangered under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*.

Both species face a range of threats in Tasmania including mortality due to shooting, poi-soning, trapping, collisions with cars, power lines, fences, aircraft and wind turbines, as well as disturbance of nest sites and the loss of suitable nesting trees. Both eagle species are known to be sensitive to disturbance both from the ground and the air around nest sites during their breeding seasons. They often will abandon nests, leaving chicks or eggs fatally exposed, due to disturbance. Stress induced by disturbance can also make chicks more vulnerable to disease and prevent the nest being used again the following year.

The importance of the TWWHA for the conservation of these two eagle species is generally poorly understood due to limited surveys of eagle nest locations in this remote and difficult to access area. Outside of the TWWHA in urban, rural and forestry areas, knowledge of nest locations is extensive due to planning system requirements for eagle nest surveys prior to development or tree harvesting activity.

Knowledge on the location of nests and optimal breeding habitat for eagles in the TWWHA will help to mitigate disturbance of various land use and management activities such as aircraft movement, recreational activity and development including construction and maintenance of park facilities that has the potential to affect the breeding success of eagles.

In 2019, helicopter surveys for eagle nests were undertaken in priority areas of the TWWHA. Additional areas were searched to fill the gaps in knowledge of eagles' use of high-altitude habitat such as the Walls of Jerusalem National Park and the Central Plateau Conservation Area, where some eagles display atypical site and nesting tree species choices.

Thirty new eagle nest locations were identified during the surveys. In addition, ten previously reported nest locations were assessed for their condition and status. The survey increased the number of eagle nests known in the TWWHA by a third, enhancing the capacity to minimise impacts and disturbance to the eagles inhabiting those sites. The new nest records from high altitude areas of Tasmania enhances our understanding of eagle nest site charac-teristics which may lead to more informed habitat modelling and decision making regarding the location of proposed developments and activities in the TWWHA.

Within the TWWHA, eagle nesting habitat is protected from many of the threats that occur outside of reserved land and is therefore of considerable importance for the conservation of both species of eagle in Tasmania.

TASMANIAN WEDGE-TAILED EAGLE

- Photo: Elise Dewar

A SHY ALBATROSS CELEBRATES A SUCCESSFUL LANDING - *Photo: NRE Tasmania*

Snapshot – Shy Albatross

Shy albatross *(Thalassarche cauta)* are endemic to Tasmania. In fact, the entire global breeding distribution is confined to just three colonies on Tasmanian offshore islands: two of which, Pedra Branca and the Mewstone islands off the State's southern coast, are located within the TWWHA. The albatrosses are one of the most threatened groups of seabirds in the world.

Even though Pedra Branca and Mewstone are remote islands, threats still remain for this species; principally impacts resulting from climate change and interactions with commercial fisheries. The predicted impact of these ongoing threats and the species' restricted breeding distribution prompted a recent up-listing of the threatened status of shy albatross to 'Endangered' under Australian environmental legislation.

Population monitoring of this species commenced in 1980 and continues to the present day, coinciding with key phases in the breeding cycle of the shy albatross. This monitoring fulfils actions under the *National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011-2016* and international voluntary actions under the Agreement on the Conservation of Albatrosses and Petrels. The remote TWWHA populations on Pedra Branca and the Mewstone islands are typically surveyed using aerial photography from a helicopter.

We have recently initiated several projects aimed at offsetting the impacts of climate change on shy albatross populations. One project has involved the trial of custom artificial nests to assist breeding birds in areas subject to increased rainfall runoff (which can erode natural nests) and where a lack of natural nest material results in low-quality nests. This successful trial, in which the breeding success of birds using artificial nests was double that of natural nests, provides managers with a tool that can be deployed to assist the population should predicted future population decline be observed. The trial has now been expanded to Pedra Branca where it is hoped that artificial nests will provide assistance to this small albatross population where competition with Australasian gannets for nesting material is high and albatross numbers are in decline.

HUNDREDS OF SHY ALBATROSS CIRCLE THE ROCKY MEWSTONE ISLAND - *Photo: Nigel Brothers*

Snapshot – Carnivorous Marsupials

The TWWHA is home to the world's four largest carnivorous marsupials: the Tasmanian devil (body weight up to 9 kg), the spotted-tailed quoll (up to 7 kg), the eastern quoll (up to 2 kg) and the extinct Tasmanian tiger (up to 35 kg). Like other marsupials, females possess a pouch (although not as well defined as in in other marsupials) in which the young are carried within until they are too large and are then left in a den while the mother hunts.

The Tasmanian tiger and Tasmanian devil became extinct on the Australian mainland prior to the arrival of Europeans in Australia possibly because of competition with dingos and increasing aridity. Eastern quolls became extinct on the Australian mainland by the 1960s as a result of loss of habitat and competition with and predation by foxes. The spotted-tailed quoll continues to occur on the mainland, along with the northern and western quolls, but is endangered there. The TWWHA is the only place on earth where the devils and quolls co-occur within a large area of protected native habitat and where their natural behaviours can largely still occur. Other carnivorous marsupials in the TWWHA include the much smaller (body weight < 200 g) antechinus and dunnart species.

A DEVIL CAPTURED BY A REMOTE CAMERA
- Photo: Save the Tasmanian Devil Program

Competition is thought to be an important force structuring Tasmania's three marsupial carnivores. Devils are behaviourally dominant to spotted-tailed quolls. Significant dietary overlap occurs between eastern quolls and female and subadult spotted tailed quolls suggesting that interspecific competition may be present, whereas eastern quolls experience limited interspecific competition from Tasmanian devils. One study has suggested that Tasmanian devils may benefit eastern quolls by making carrion more available.

Various research and monitoring programs in the TWWHA using camera surveys, live trapping and direct observation continue to record devils and quolls throughout the TWWHA. Although devil facial tumour disease (a rare transmissible form of cancer that can be spread when devils are fighting or mating) has been recorded in the TWWHA, large parts appear to remain free of the disease or have low disease prevalence.

THE TRACKS OF A TASMANIAN DEVIL IMPRINTED IN THE BEACH SAND ON THE SOUTH-WEST COAST OF THE TWWHA -
Photo: Natural Resources and Environment, Tasmania

A SPOTTED TAILED QUOLL CAPTURED USING A REMOTE CAMERA SET UP ON THE CENTRAL PLATEAU OF THE TWWHA - *Photo: Natural Resources and Environment, Tasmania*

Snapshot – Central Plateau Wildlife

The TWWHA provides a large area of protected native habitat for a range of wildlife species that contribute to the property's OUV including primitive, endemic, rare and threatened species. Although the TWWHA has a high level of legal protection and relatively undisturbed ecosystems, it is subject to pressures associated with invasive organisms, climate change, altered fire regimes and developments. Recent monitoring of priority wildlife, including both native and introduced species, was conducted using 42 remotely triggered camera stations located in the Central Plateau, Lake Augusta, Great Western Tiers Conservation Area and the Top Marshes Conservation Areas. The monitoring was focused on fallow deer, Tasmanian devil, eastern quoll, spotted-tailed quoll and common wombat. The distribution and prevalence of devil facial tumour disease (DFTD) that affects Tasmanian devils and sarcoptic mange that affects common wombats, and the impact of bushfires were also investigated.

15,884 images of mammals were recorded, representing 4,147 visits by 15 species. The five most commonly recorded species were Bennett's wallaby (2,511 visits), brushtail possum (363), common wombat (278), eastern quoll (272) and Tasmanian devil (200). Sixteen species of bird were recorded from 743 images/285 visits. The most commonly recorded birds were black currawong (75 visits), forest raven (45), Australian magpie (45) and Australasian pipit (39). Two devils showing signs of DFTD were detected. No wombats with signs of mange were detected.

Tasmanian devils, eastern quolls and wombats were frequently and widely detected suggesting that these species are common in the survey locations. There was evidence to suggest that there may be an inverse relationship between Tasmanian devil and spotted-tailed quoll occupancy, and similarly between eastern quoll and spotted-tailed quoll.

In addition to fallow deer, four other introduced mammal species were detected: cat, European rabbit, black rat and house mouse. Cats occur throughout Tasmania including remote areas and European rabbits are widespread on the Central Plateau, thus their presence at the locations surveyed in our study is not unexpected.

The monitoring undertaken continues to highlight the presence of a wide range of endemic wildlife with the occasional presence of introduced species, primarily in areas around the northern perimeter of the property.

Snapshot – Anaspides

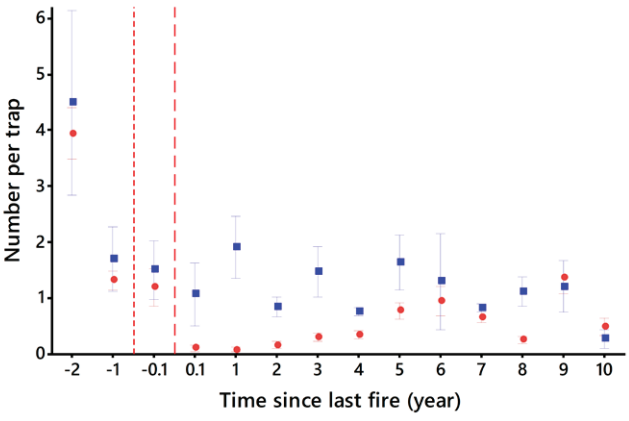
All extant species of the "shrimp-like" family Anaspidesidae *(Anaspides*, *Allanaspides* and *Paranaspides)* occur in Tasmania and most are restricted or largely restricted to the TWWHA, which provides secure habitat. These species are regarded as "living fossils" because they bear a very close resemblance to fossil species from the Triassic period (200 - 250 million years ago). The most well-known species, the *Anaspides*, is commonly observed in alpine pools and tarns but also occurs at lower altitudes and in caves. At the time the TWWHA was listed, only two species were recognised, but following the collaboration of local and international researchers, five new species have now been described and it is possible that more may be discovered.

Two species of *Allanaspides* (Hickman's allanaspides and the marsh allanaspides) lost a significant part of their range (85–94% and 59% respectively) due to the inundation of the Gordon and Serpentine catchments for hydroelectricity in the early 1970s. Surveys conducted since the listing of the TWWHA, have mapped the distribution of both species, with both predominantly occurring in pools in buttongrass moorland around Lake Pedder and Lake Gordon. The marsh allanaspides was also found to occur in the deepest parts of Lake Pedder. Although both species are considered to be secure in the TWWHA, there is concern that bushfires may burn the peat that support the pools that these species live in. This is especially the case for Hickman's allanaspides, which has a very restricted distribution, and a large part of its range is subject to low intensity planned burns to manage the threat of bushfires.

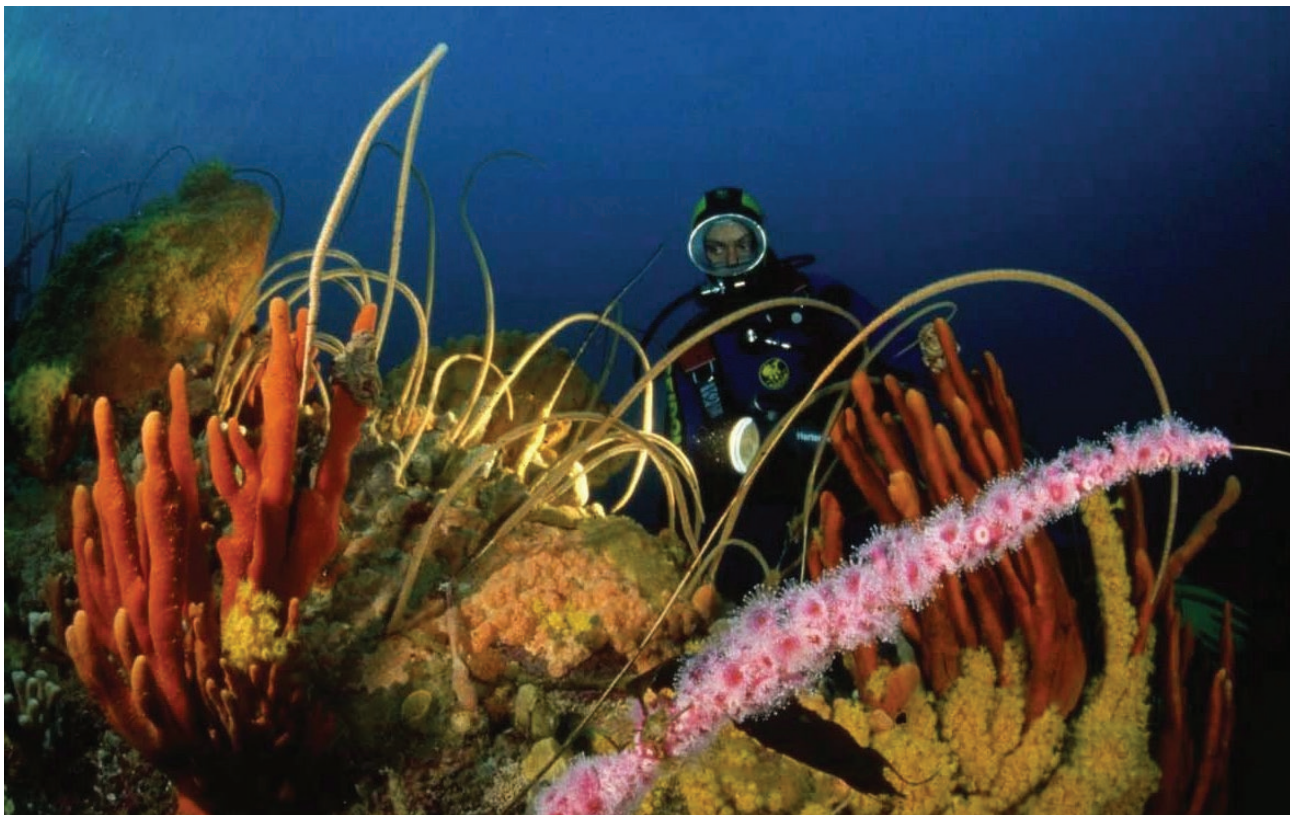
ALLANASPIDES - *Photo: John Gooderham*

BACKLIT PHOTO OF ANASPIDES SWAINI COLLECTED FROM THE KHAZAD DUM CAVE - *Photo: Shane Ahyong*

To assess this risk, a study into the resilience of Hickman's allanaspides to low–moderate intensity fires was conducted over 13 years. This investigation found that Hickman's allanaspides and its habitat are resilient to fire provided the fire regime does not degrade or lead to a complete loss of peat. However, climate change predictions for warmer and drier summers in western Tasmania will increase the risk of peat loss and consequent potential impacts on the species.



Planned burns on small (30 x 30 m) experimental blocks (red circles) caused a short-term (five years) decrease in the number of Hickman's allanaspides compared with unburnt control blocks (blue squares).



BATHURST CHANNEL WHIPS AND SPONGES - *Photo: NRE Tasmania*

Snapshot – Port Davey — Bathurst Harbour

Port Davey and associated Bathurst Channel and Bathurst Harbour in south-western Tasmania represents one of the world's most anomalous estuarine systems. These two connected embayments form the only large estuarine system in southern Australia without significant human impact.

Worldwide across temperate regions, coastlines are generally heavily-populated and developed, but the Port Davey–Bathurst Harbour estuarine system ranks as near pristine. It also arguably comprises the world's most unusual estuary in both a physical and ecological sense. Investigations to date have found a relatively large component of undescribed species, including numerous possible endemic species that have not been recorded elsewhere. The past documented presence in 1992 of the near endemic Maugean skate is highly unusual. Also unusual is the presence of the world's most southerly and isolated temperate seagrass beds, and giant kelp forests. The benthic rocky reef community in the Channel between Port Davey and Bathurst Harbour is unlike any from coastal and estuarine reefs elsewhere. Bathurst Channel showcases an array of filter-feeding bryozoans, sponges, anemones, sea pens, soft corals, hard corals, seawhips, tubeworms, and ascidians. Many undescribed invertebrate species have been found as well as species only recorded elsewhere in deep offshore waters.

The major threats to biodiversity values of the Port Davey region can be categorized as: boating; fishing; recreational divers; effluent release; introduced species; onshore activities; changes in freshwater inputs; and climate change with its associated sea level rise.

Repeated monitoring of bank landforms in Port Davey—Bathurst Harbour in response to concerns about climate change impacts and increased tourism potential, has shown evidence of widespread erosion and whilst many of the banks present are susceptible to vessel wave wake, the distribution of erosion indicates that, with the possible exception of Melaleuca Inlet, vessel wake is not the primary cause of the erosion. Results from our most recent monitoring provides further support to the previously held hypothesis that sea level rise is the most likely cause of the observed erosion.

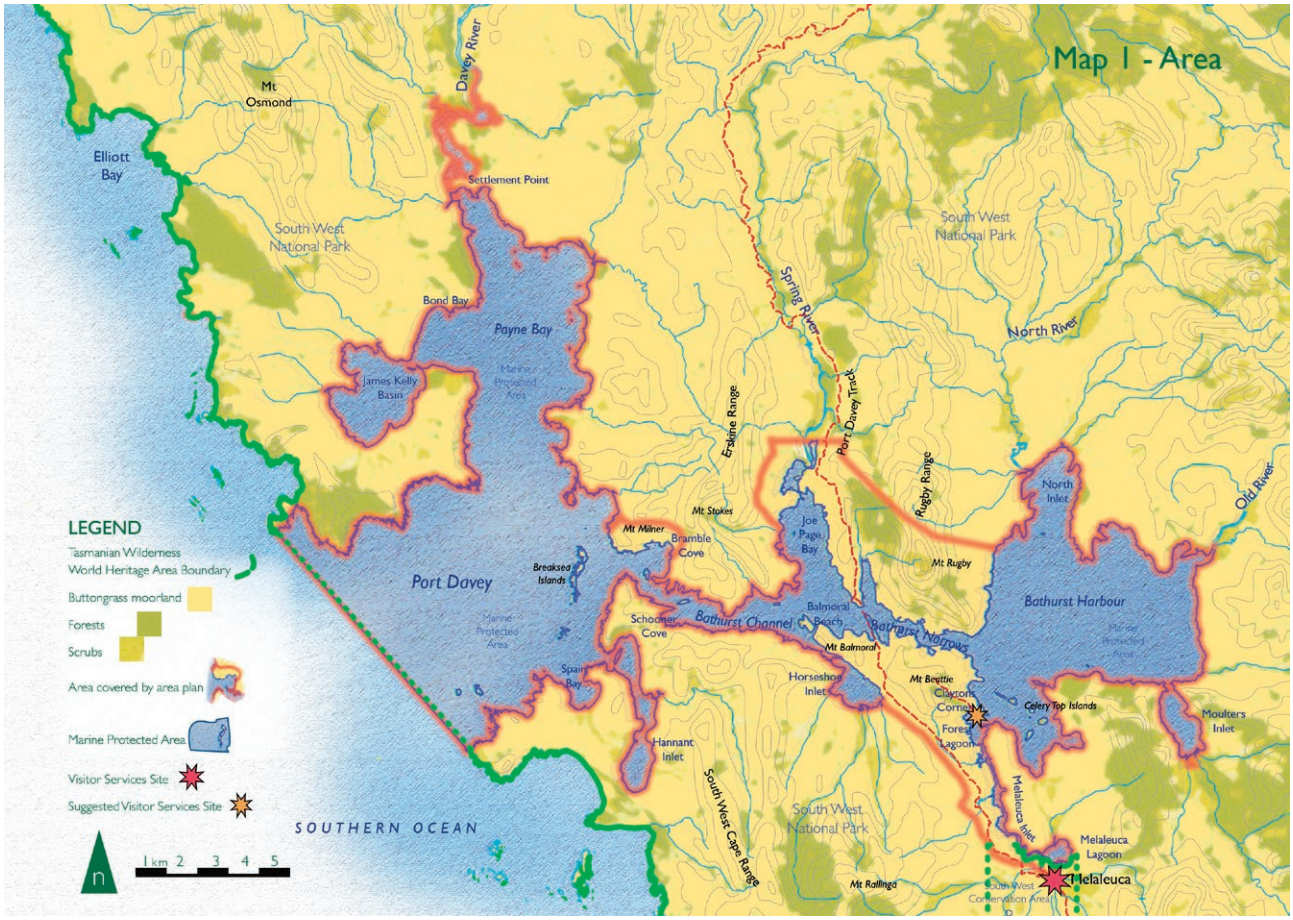
In response to the various threats facing this unique system, the Tasmanian Government has enacted an adaptive management regime that includes a multi-zoned marine protected area and the largest 'no-take' estuarine protected area in Australia. Although the Port Davey estuarine system has historically been protected by its isolation, proactive and adaptive management based on ongoing monitoring of ecological condition, bank erosion rates, impacts of rising sea levels and social and environmental pressures, is a necessary prerequisite for the long-term persistence of the area's unique values and its contribution to the OUV of the TWWHA.

From top to bottom

ESTABLISHING MONITORING QUADRAT TO MEASURE BANK EROSION AT PORT DAVEY'S HANNANT INLET - ***Photo: Tim Rudman***

A COLONY OF SEA PENS ON THE FLOOR OF BATHURST CHANNEL BETWEEN PORT DAVEY AND BATHURST HARBOUR - ***Photo: Fred Baverham***

PORT DAVEY - BATHURST HARBOUR



A DEPARTMENTAL KARST OFFICER STANDS IN THE RIVER BED OF EXIT CAVE WITHIN THE TWWHA. STALACTITES HANG FROM THE CEILING AND LIME DEPOSITS COVER THE WALLS
Photo: Rolan Eberhard

Geodiversity Values

The TWWHA's complex and unusually complete geological history stretches back more than a billion years, but also includes 3 billion year old fragments of re-deposited rock, and is a valuable record of evolution.

Features include two-kilometre deep sequences of limestone that have extensive karst and glacio-karst landforms. Caves in karst areas contain fossil and sub-fossil deposits of extinct species such as marsupial megafauna and the thylacine *(Thylacinus cynocephalus)*. There are also spectacular light displays by the Tasmanian glow-worm *(Arachnocampa tasmaniensis)*. The TWWHA contains glacial legacies from three major phases dating back as far as 720 million years. The New Zealand and Patagonian similarities of primitive and relict floral and faunal groups, along with extensive outcrops of Jurassic dolerite, provide evidence of Gondwanan connections and the break-up that began about 180 million years ago. In many respects, the area's geology has a closer affinity with parts of Antarctica than mainland Australia.

The TWWHA has the longest undisturbed stretches of temperate, high-energy rocky and sandy coastline in south-eastern Australia. There is a significant diversity of beach barrier (dune) systems, including bay head and river mouth, cliff-top, parallel and transgressive dunes. An excellent example of a recurved baymouth spit is located at Prion Beach on the south coast, and Louisa Bay has a well-developed tombolo formation. The oldest interglacial Pleistocene dunes and sand sheets date back at least 125 000 years. More recent dunes were formed after deglaciation and the relative stabilisation of sea levels about 6,000 years ago.

As one of the largest conservation reserves in Australia, the TWWHA is of great national significance. It is known for large intrusions of Jurassic dolerite that are not found elsewhere in

Australia; its glacially formed landscapes are the nation's most extensive; and karst features, such as caves, are among the longest, deepest and best decorated.

The condition of the caves and karst of the TWWHA is assessed as 'good with some concern'. The majority of caves remain in excellent condition but impacts have occurred in show caves and wild caves accessed by visitors.

Snapshot — Caves & Karst

WILD CAVES

Wild caves are caves in chiefly natural condition, with no paths or permanent lighting for visitors. Most caves in the TWWHA are wild caves – the exact number is unknown, because the TWWHA contains large areas of cavernous limestone and dolomite which are not fully explored. The known caves include the deepest and some of the longest caves in Australia, as well as caves with exceptional mineral formations. Certain caves were occupied by Aboriginal people – the earliest evidence for human presence in Tasmania (40 000years ago) is found in caves which contain ancient campsites and ochre hand stencils. Caves also have and still do provide habitat for rare cave-adapted invertebrate animals. A few caves contain rich fossil deposits, providing precious evidence of extinct giant marsupials.

Most caving activity in the TWWHA takes place in relatively accessible caves on the periphery of the TWWHA. A few caves are visited by hundreds of caving parties each year, but this is the exception rather than the norm. Visitors may inadvertently impact caves, which are often low energy environments where natural rates of change are very slow. Consequently, even minor impacts tend to accrue and in time can cause substantial damage. Common impacts include accidental breakage of formations (stalactites etc), transfer of mud and clay onto surfaces which cannot be cleaned, and trampling damage to cave floors. On rare occasions, caves are vandalised with graffiti and deliberate breakage of formations.

The PWS Cave Access Policy seeks to balance cave conservation with demand for access to caves. It does this by classifying and zoning caves based on their suitability for different patterns and levels of visitation. The cornerstone of this approach is an assessment of whether a cave is robust and suitable for regular visits, or sensitive and requiring a higher level of protection. We are working with caving groups to progressively apply the Cave Access Policy to priority caves, based on risk to cave values, and augmented by practical measures to limit further damage. For example, clearly defined routes have been established in sensitive cave passages. Restoration work has also been undertaken at several caves.

Condition monitoring over time indicates that a small number of accessible caves have been substantially impacted by visitors, and many have experienced some loss of condition due to visitor activity, although their condition overall would be rated as good. These impacts virtually all pre-date the 2014 Cave Access Policy. The majority of caves are rarely if ever visited, due to their remoteness, and remain in pristine or near-pristine condition.

A MASS OF BONES FROM AT LEAST TWO ANIMALS ACCUMULATED IN THE SEDIMENTS IN THE BOTTOM OF CAVES, WHERE ANIMALS HAVE FALLEN IN AND CANNOT EXTRICATE THEMSELVES. THE BONES ARE THEN GRADUALLY COVERED IN SEDIMENT CARRIED BY WATER *- Photo: Rolan Eberhard*

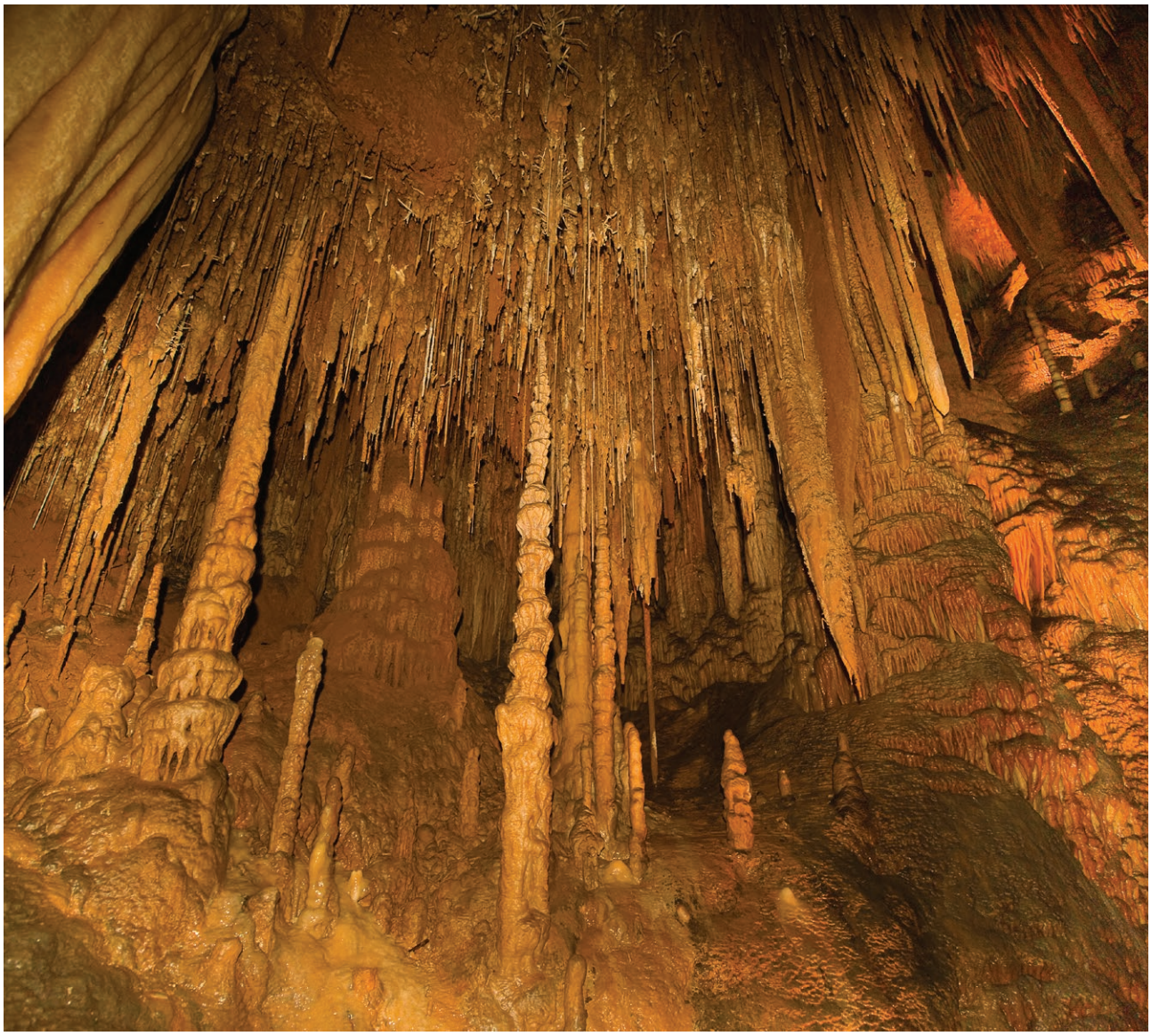
SHOW CAVES

Three TWWHA caves are developed show caves promoted for tourism: Marakoopa Cave and King Solomons Cave (Mole Creek Karst National Park) and Hastings Caves (Hastings Caves State Reserve). The former received 63,000 visits (8% of TWWHA visits) and the latter received 46,000 visits (6% of TWWHA visits) in 2017-2018. The Mole Creek NP has been recently expanded by 2850ha to further protect and manage this important value.

Show caves are engineered with lighting and pathways to facilitate public access and reduce visitor impact. Despite this, large numbers of visitors can still have a cumulative impact on show caves. For example, visitors shed lint that accumulates in the cave and can affect the environment. TWWHA show caves are cleaned regularly to reduce lint and maintain cave condition.

Engineering caves for visitors is itself an impact often with substantial physical modifications, such as enlarging entrances, installing electrical wiring and laying concrete. There may also be ongoing impacts, for example where artificial lighting triggers growth of moss and algae in what would otherwise be total darkness. This problem can be reduced by careful placement of lights and use of lower energy output lighting. However, in all cases the present infrastructure is the cumulative result of management decisions going back many decades with variable impact on the cave environment.

STALACTITES OF ALL SIZES HANG FROM THE CEILING OF HASTINGS CAVE WHILST STALAGMITES RISE UP TO MEET THEM - *Photo: David Clark Photography*



Snapshot — Soils

The condition of the soils of the TWWHA is assessed as 'good with some concern'. Bushfires have caused significant impact in some localized areas and subsequent erosion has led to further impacts. Organic peats can take centuries to reform after being incinerated by the intense fires.

Soils are a product of the landscape in which they've formed, reflecting the influence of the geology, climate, topography, plants and animals. Given this, in an area as diverse as the TWWHA, it is not surprising that there are a huge range of soil types. They vary from the shallow, eroded and rocky soils of the mountain tops, through to the young, poorly developed, deep sandy soils of the coastal dunes. Other soil types include deep red clayey soils of wet forests, almost permanently wet soils of the swamps and marsh-lands, the dramatic podosols of older sand dunes, and unusually for Australia, a very wide-spread organic soil (often referred to as peat).

Soils can be described as mineral or organic. Mineral soils are most common, and have clayey, silty or sandy layers formed from weathered rocks. In contrast, the organic soils are mostly made of decaying plant remains, accumulated over thousands of years like a giant layer of wildland compost. Most of mainland Australia is so hot and dry that organic soils are restricted to tiny pockets around wetlands and in alpine areas. But in cool, wet western Tasmania, organic soils blanket the landscape, covering the flats, hillslopes and in some cases the mountain tops. These organic soils have special conservation value and form globally unique features such as stripped mires, deep freely drained rainforest peats and fields of peat mounds. They are also important stores for water, nutrients and significant amounts of carbon, and provide habitat for countless animal and plant communities.

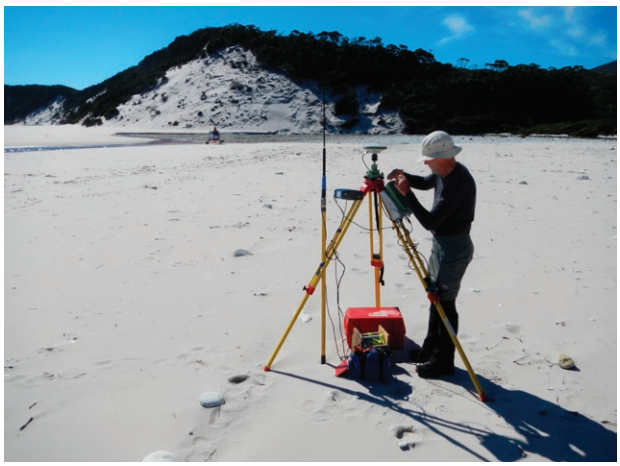
Soils landscapes are dynamic systems that change with the impacts and influences from their environment. Bare soils are vulnerable to erosion by wind and water, and in alpine areas by frost. Humans impact soil through fire use and by vehicle and foot traffic which causes compaction and erosion. Introduced animals such as lyrebirds, deer and rabbits can also threaten soil health and structure.

In the TWWHA, bushfires are the main cause of bare soils and erosion. Organic soils are especially impacted, as the soil itself can be burnt during a bushfire, and what remains can be very prone to erosion. These processes are thought to be responsible for the bare areas of moorland in the south-west where most organic soil is gone, leaving a patchwork of remnant soil surrounded by bare infertile gravels. In the 1960's on the Central Plateau, fire damaged the organic surface horizon and started an erosion problem that continues to this day in many areas.

Apart from fire and localised human and introduced animal impact, most of the erosion processes in the TWWHA proceed at natural rates and are part of the natural character of the area. With forecasts of a changing climate however, warming climatic conditions may lead to drier conditions for lengthier periods of the year that will inevitably result in more fire, and increased rates of soil loss.

Understanding soils and knowing where the globally significant peat mounds are located, means that the organic soil attribute is managed and the OUV of the property maintained.

SOIL ANALYSIS BEING UNDERTAKEN AT NRE TAS LABORATORY - ***Photo: Rob Moreton***



UNDERTAKING A SURVEY OF BEACH AND DUNE EROSION AT WINDOW PANE BAY

- Photo: NRE Tasmania

The condition of the south-west beaches and the coastal and inland dunes of the TWWHA is assessed as 'good with some concern'. The remoteness of the beaches helps maintain these fragile systems in good condition. However bushfires and sea level rise continue to pose a threat for these sensitive features.

Snapshot — Beaches and Dunes

The TWWHA's 750 km of coastline is remote and one of the least disturbed by human activity of any coastline in Australia. Located in the stormy 'Roaring Forties', it is exposed to strong wind and heavy oceanic swells. Whilst much of the coast is rocky and precipitous, there are also spectacular beaches and extensive coastal dunes. Aboriginal people lived on this coast for generations and material evidence of their culture survives as mid-dens, hut depressions and rock engravings. The layers of sand in these coastal dunes record changing environmental conditions over thousands of years, making them an invaluable archive of human and geological history. Plants and animals which occur in few other places, colonise the coastal fringe.

Sea level rise in response to climate change is a threat to these coastal systems. Sea level rise in Tasmania is currently tracking at about 1 mm every year [actually 0.8-1.5 mm/year since the 19th century]. Scientists expect that average global sea level will be 0.4-0.8 m higher by the end of this century. Consequently, the TWWHA coast will very likely change considerably during the next 50 years. We can expect to see flooding of low-lying areas and increased erosion of beaches and dunes, as waves attack the coast at progressively higher levels.

Historic air photos and reports from bushwalkers indicate that TWWHA beaches and dunes have experienced major erosion events in the past. To an extent this is normal, because coastal landforms exposed to wind and waves are naturally dynamic. Typically, storms cause erosion as sand washes into the sea or blows inland, followed by periods of re-building as sand slowly accumulates back onshore. A beach or dune is said to be in *dynamic equilibrium* if erosion and re-building balance each other over time. If erosion exceeds re-building then beach recession occurs; if re-building dominates then beach accretion occurs.

Data collected during field surveys in 2014-2017 and by examining historic air photos, showed no clear trajectory of change on several major beaches, suggesting a state of dynamic equilibrium. Although some of these beaches appear to be still recovering from major past erosion events, a large continuing onshore supply of sand from the shelf is considered to be still protecting them from net sand loss and receding in response to sea-level rise. However, it was also observed that Prion Beach, Window Pane Bay East, also Ocean Beach have recently shown a change of behaviour towards more persistent erosion and recession. It is thought that this is a sea level rise effect and may be a precursor of a swing towards net overall recession at most beaches. Further monitoring is required to verify this.

ASSORTED MAMMAL BONES FOUND IN THE SEDIMENTS OF A CAVE WITHIN THE TWWHA, PROVIDING AN IMPORTANT FOSSIL RECORD
- Photo: Grant Dixon

Snapshot — Fossils

The condition of the known fossil deposits of the TWWHA is assessed as 'good with some concern'. Illegal activities and visitors to caves have caused moderate impact in some localized areas.

Fossils are an important scientific resource for several reasons. Firstly, they help us understand extinct life and the evolutionary processes which underpin biodiversity. Secondly, they allow us to correlate different rock units, because certain fossils provide critical markers for different geological periods. Thirdly, fossils are evidence of specific conditions at a place and time when the host rock was laid down, so they tell us about ancient environments. Irrespective of their scientific value, fossils are a source of curiosity and wonder to many people.

The geological history of the TWWHA goes back more than a billion years, taking in major stages of Earth history. These range from ancient Precambrian time, when conditions on Earth were profoundly different to what they are today, to the geologically recent Holocene of the last few thousand years. During this very long period, life progressed from simple aquatic forms, such as stromatolites, to the incredible diversity of marine and terrestrial plants and animals we see today. This diversification of life is punctuated by global extinction events, when diversity was lost only to be replaced by new forms. Fossils are the only record we have of these extinct life forms.

Fossils of exceptional interest within the TWWHA include: Precambrian stromatolites (layered mats of micro-organisms, the earliest fossil evidence for life on Earth); diverse Palaeozoic invertebrates (cephalopods, agnostids, trilobites, brachiopods, dendrioids, stromatoporoids, graptolites, corals), reflecting an extended period when the diversity of life was found chiefly in the oceans; and

terrestrial plants and animals of the Cenozoic, when mammals thrived following the extinction of the dinosaurs. Additionally, fossil pollen preserved in lakes and wetlands provides a record of changes in vegetation over geological time in response to effects such as fire frequency and climate. The fossil pollen record of the Darwin Crater, which was formed by a meteorite collision about 700 000 years ago, is one of the lengthiest in the Southern Hemisphere. Although not presently recognised as an OUV attribute, TWWHA fossil sites are considered nationally or globally significant.

Our capacity to comprehensively characterise the fossil heritage of the TWWHA and to report on its condition is constrained by the fact that large parts of the TWWHA are remote, are not mapped in detail by geologists and there are fewer roads and excavations with potential to expose fossils. The presently known sites include natural and artificial exposures, such as quarries and road cuttings. Both are affected by natural weathering which can damage fossils or obscure access to them. A further threat is illegal collection of fossils for private collections or sale. It is difficult to assess the scale of illegal collection of fossils within the TWWHA, however, it seems likely that this problem chiefly affects more accessible fossil sites outside the TWWHA. Fossils can also be damaged inadvertently during earthworks, although this also has potential to reveal hitherto unknown fossil deposits. Inadvertent damage may also occur when people explore caves and trample sediments which contain fragile bones. This risk is mitigated by the fact that most caving groups are aware that bones are significant and actively avoid disturbing them.

Looking ahead, the key challenges are to foster appropriate research to better understand the nature and significance of the TWWHA fossil heritage, and to ensure that systems are in place to understand and manage the risks to its integrity.

From top to bottom

FOSSILISED SHELLS EMBEDDED IN THE LIMESTONE AT THE BOTTOM OF A CAVE IN THE TWWHA. THESE FOSSILISED CAVE DEPOSITS PROVIDE AN IMPORTANT RECORD OF THE PAST CLIMATE AND DISTRIBUTION OF ANIMALS ACROSS THE TWWHA - *Photo: Rolan Eberhard*

A KARST OFFICER COLLECTING SAMPLES FROM THE BASE OF A LIMESTONE CAVE WITHIN THE TWWHA - *Photo: Rolan Eberhard*

BONES OF A MARSUPIAL FOUND IN THE BOTTOM OF A CAVE IN THE TWWHA WITH A 10CM MEASURE PLACED NEXT TO THE SKULL OF THE ANIMAL FOR CONTEXT - *Photo: NRE Tasmania*

A New OUV Attribute? — Living Stromatolites

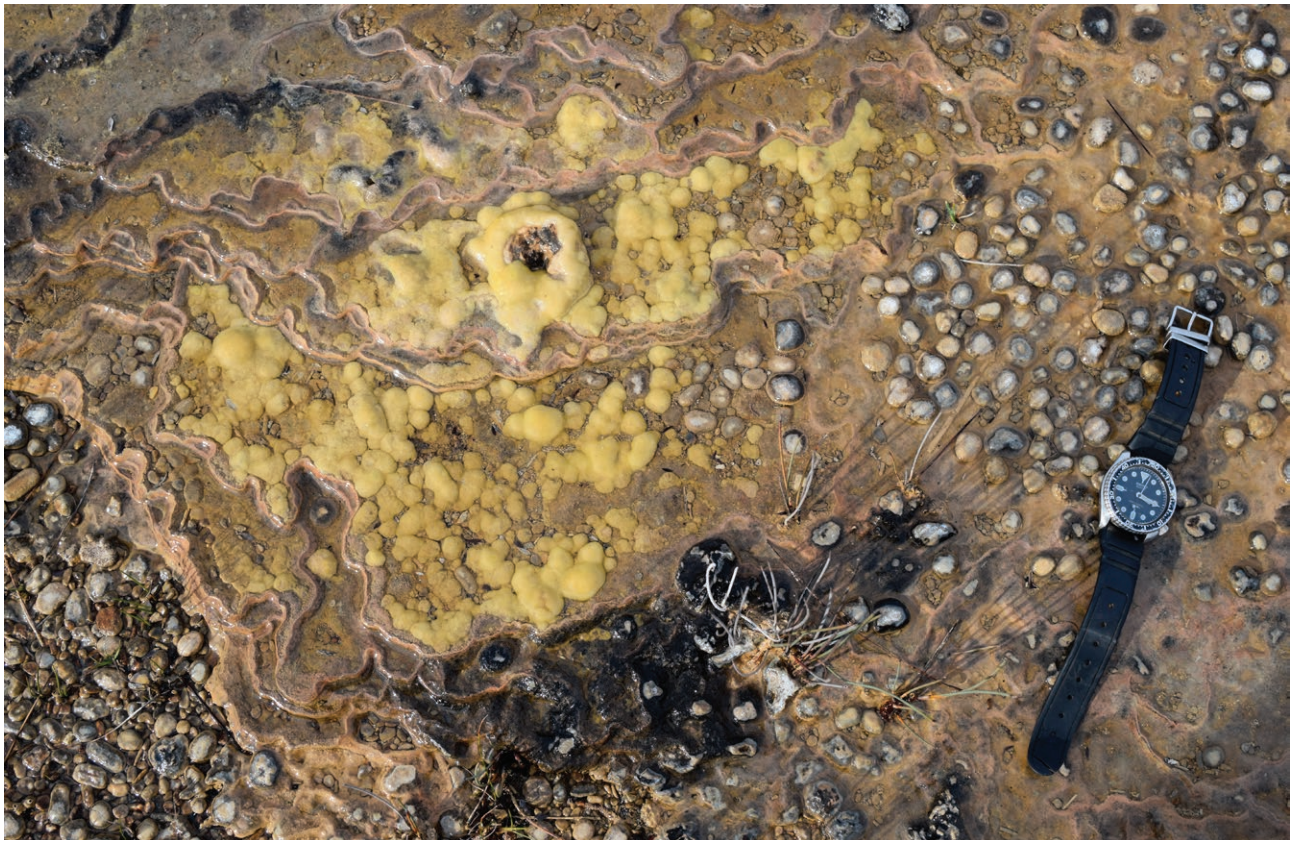
In 2017, Departmental and University of Tasmania scientists found living stromatolites (one of the oldest known life forms) in the Giblin River catchment of the TWWHA.

Only a few rare environments on Earth have been found to host stromatolites and only where unusual water chemistry allows them to develop. Such places include super salty environments and a few freshwater environments with their own peculiar chemistry. The most well-known living stromatolites in Australia are the shallow marine stromatolites in Shark Bay in Western Australia.

A team of researchers uncovered stromatolites while surveying swampy wetlands in the TWWHA. The stromatolites were found by accident when investigating a unique and strange type of mound spring wetland which we call peat-bound karstic wetlands, and which only occur in an area north of Port Davey in south-west Tasmania. The stromatolites are yellow-green globular growths in the sand and gravel beds of the mound spring.

Cold water coming out of the mound spring is mildly alkaline containing lots of calcium and bicarbonate. This water permeates the soil for a short distance before dissipating in the acidic water of the surrounding peat blanket bogs. The stromatolites are growing on wetted ground, but the top several centimeters of the stromatolite towers where the bacteria grow, are bathed in air. That is a highly unusual configuration, but the region does get 3m of rain a year. The Giblin stromatolites are dwarfs compared to those at Shark Bay, with the largest of ours around 10cm across, but most are much smaller, and they have fine internal calcite layers.

The structures are being formed by a complex of ancient bacteria, predominantly cyano-bacteria. When we looked at the DNA of the bacteria in these stromatolites we discovered they seem to be unique and unlike those seen in stromatolites anywhere else on Earth, including those in other freshwater and lake environments.



CLOSE-UP OF YELLOW STROMATOLITE COLONIES FOUND IN THE SOUTH-WEST OF THE TWWHA - *Photo: Rolan Eberhard*

CLOSE-UP OF YELLOW STROMATOLITE COLONIES FOUND IN THE SOUTH-WEST OF THE TWWHA. A 10CM RULER IS NEXT TO THE STROMATOLITES TO PROVIDE SCALE AND INDICATING THE STROMATOLITES ARE ONLY A FEW CENTIMETRES IN SIZE - *Photo: Rolan Eberhard*

The stromatolites have few predators but it seems that snails might be one. Few live snails were found in the vicinity of the stromatolites whilst piles of empty shells were found further away from the spring. This would imply that the chemistry of the water, whilst allowing the development of the stromatolites, was not very welcoming for the snail. Some of the discarded shells were so encrusted with minerals from the water that they were barely recognizable as a snail's.

It would seem that the environment that leads to a stromatolite forming is an Achilles heel in the construction of the snail's shell, which is mainly calcium carbonate. And whilst the concentration of empty snail shells around the area would imply that they are attracted to the stromatolites or the mound springs for grazing, in the alkaline waters of these springs, the carbonate in the water anneals to the shell of the snail, causing them to grow increasingly heavy and unwieldy. The heavier than normal shell becomes a burden for the snails and they perish from malnourishment.

The presence of a thriving colony of stromatolites surrounded by dead snails helps us understand why stromatolites are rare. From fossils we know that stromatolites were the dominant form of life on earth for millions of years. Then, at about the time when the primitive animals first appeared in the geological record, stromatolites went into decline. Scientists speculate that they crashed because the new organisms were feeding on the bacteria which helps give stromatolites structure. This appears to explain why stromatolites survive today only in places where it's too hot or salty or otherwise difficult for snails and other bacteria eaters to live.

Our discovery of this ancient life form in a terrestrial setting adds to the world-wide understanding of these rare stromatolites because peat-bound karstic wetlands are unlike all other reported habitats for stromatolites. These wetlands are not saline or geothermally heated like stromatolite habitats in some other parts of the world. Prior to this discovery, we had only ever known of stromatolite bacteria in ancient fossils within the TWWHA.

New OUV Attribute — Peat Mounds

Peat mounds are enigmatic features found on a handful of buttongrass moorland plains in western Tasmania. The mounds are small, but rise distinctively from their flat surroundings, roughly circular, one to two metres high, and typically with slightly different vegetation. Seen from the air, mound fields appear distinctly odd, almost artificial, a case of landscape acne with no intuitive explanation.

Theories abound as to how the peat mounds developed. A curious feature of the mounds is that the water table inside the mound is sometimes higher than the surrounding plain. This strange sucking upward of water into the mound peat may well be im-portant to mound creation and maintenance. However, these features are still so poorly studied in Tasmania that their origin cannot be stated with any certainty.

Whilst they only exist in a handful of locations in south-west Tasmania, the locations have one thing in common – they are all very flat. The only other locations, anywhere in the world, where similar mound features have been reported are two sites in the far north of Scotland.

The biggest threat to Tasmania's peat mounds is fire. Like the soil of the plains around them, peat mounds are made entirely of organic soil deposits. These are fragments of plants, accumulating on the surface and only partially decomposing. Over thousands of years, this material collects to form an organic soil, often black or dark brown, sometimes reddish brown. While it looks and behaves like soil, this material has been grown, rather than weathered from rock. Like the plants its derived from, it can burn. Mounds often come through fire unscathed, but if the fire is intense enough, and it occurs when the soil is dry, mounds will smolder like enormous heat beads, damaging the form and destroying thousands of years of peat formation. This occurred to some of the Florance Creek mounds in 2019, with depressions up to one metre deep forming in the centre of the mounds as a result of the bushfire.

Tasmanian's peat mounds have been assessed by the Tasmanian Geoconservation Database Reference Group as being landforms of international significance, because of their distinctive form and their rarity across the globe. They are an example of not only a superlative natural phenomenon but also an outstanding example of significant ongoing geological processes in the development of landforms, and as such contribute to the property's OUV.

AERIAL VIEW OF SEVERAL PEAT MOUNDS LOCATED ON CROSSING PLAINS - *Photo: Mike Comfort*

SCIENTIST STANDING ATOP A PARTIALLY BURNT PEAT MOUND FOLLOWING THE 2013 FIRES IN THE SOUTH-WEST OF THE TWWHA - *Photo: Mike Comfort*

WESTERN ARTHURS HERBFIELD - *Photo: Tim Rudman*

Environmental Attributes

Apart from the natural value attributes of the TWWHA that contribute to its OUV, the environmental characteristics of the TWWHA are just as important to ensure that the natural values remain in good or pristine condition and people can continue to experience the wilderness that is the TWWHA.

A wide range of environmental characteristics have been assessed and where needed, management actions implemented to address negative impacts. These characteristics can range from the personal experience of wilderness and soundscapes of the TWWHA through to air, water and litter pollution. Given the remoteness of the TWWHA and its wilderness characteristics, it is not surprising that in general, the environmental characters are representative of a near-pristine environment. However human presence and activities both within and adjacent to the property brings with it a potential for degradation in environmental quality.

Upgrading infrastructure relating to sewage treatment and drinking water supply within the TWWHA has meant that the risk of impact on the undisturbed catchments of the TWWHA has been significantly reduced.

Visitors to the TWWHA experience some of the world's cleanest air, spectacular viewfields and a natural soundscape that conveys a sense of tranquillity due to its remoteness from urban and industrial noise sources. The wilderness value, both tangible and intangible, experienced by users of the property is very high due to the lack of infrastructure and large expanses of intact forest and mountainous landscapes where visitors experience solitude and tranquillity and rarely see another human being. The flight paths and landings of small planes and helicopters within the TWWHA are managed through the Fly Neighbourly Agreement.

SUNRISE REFLECTED ON THE STILL WATERS OF A SHALLOW WETLAND ON THE CENTRAL PLATEAU - *Photo: Tim Rudman*

Snapshot — View-fields

Aligned with wilderness quality and people's perception of the "wilderness experience", a view-field is a somewhat abstract term that attempts to highlight the user's perception of the expansive field of view available to them is some wild and natural landscapes. Visual and aesthetic values are components of a landscape that help define its very essence, its character and degree of uniqueness. There is increasing public awareness of the extraordinary view-field qualities of the property and the opportunities for people to experience that quality.

The natural beauty of the TWWHA comes from the expanses of dramatic and varied landscape. The potential for visitors to the TWWHA to view the landscape depends upon their location, position, angle of view, direction of view, distance seen, screening, and focal points. Human modification within a person's view-field is considered to have a greater influence on their perception of wilderness than an identical modification out of sight of the person, but a similar distance away.

Views of the dramatic and varied wilderness landscapes of the TWWHA remain largely intact across much of the property. In some areas though, views are impacted by the effects from bushfire, erosion, water impoundment and water level fluctuations, and in other areas by roads, tracks and other infrastructure. Fire scars can be short or medium term in their impact on this character. Further fire, and increasing development are the most likely threats to the aesthetics that make up the visitor experience of the TWWHA view-fields.

THE SPECTACULAR VIEW-FIELD OF THE DU CANE RANGE WITHIN CRADLE MOUNTAIN LAKE ST CLAIR NATIONAL PARK WITH MT GOULD ON THE RIGHT, THE ACROPOLIS IN THE MIDDLE AND MOUNT GERYON ON THE LEFT - *Photo: Tim Rudman*

THE ICONIC SILHOUETTE OF CRADLE MOUNTAIN AGAINST THE MILKY WAY CONSTELLATION, WITH STARLIGHT REFLECTIONS ACROSS DOVE LAKE.

Photo: Santanu Banik Photography

Snapshot — Dark Skies

Dark skies are an important natural, cultural, and/or scientific resource value and a natural resource that should be protected. The ongoing loss of a dark night sky for much of the world's population is a growing issue that impacts not only astronomical research, but also human health, ecology and ecosystems, and energy conservation.

Light pollution has a negative impact on animals and plants in a variety of ways. It can disorient animals, affect mating, alter predator-prey behavior, confuse migration, and influence animal physiology. A place like the TWWHA preserves not only darkness for the benefit of people; more importantly, it has allowed flora and fauna to thrive in cycles of light and dark, varying in length only by the seasons, for millions of years.

The TWWHA remains virtually unimpacted by light pollution. Dark skies, starry nights and astonishing aurora displays have been part of the TWWHA experience long before the area was designated as a World Heritage Area. One factor that makes this possible is simply the sparse human presence across the property. The obvious impression one gets of wilderness in the TWWHA, particularly at night, is the lack of visible artificial light indicating a building or a town. Most urban areas have such an abundance of light that very few stars can be seen. But at night in the TWWHA, provided the weather is good, the starscape is remarkable and on some nights when the Aurora Australis is active, it yields an experience that will stay in your memory for some time.

Snapshot — Landscape wilderness quality

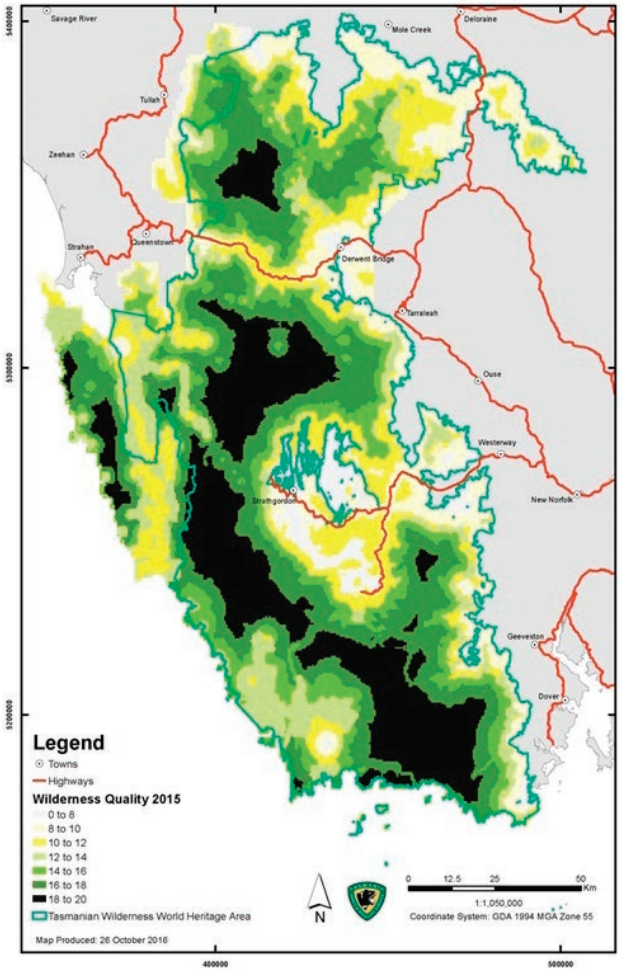
The TWWHA Management Plan 2016 defines wilderness as "..... an area that is of sufficient size, remoteness and naturalness to enable the long-term integrity of its natural systems, diversity and processes, the maintenance of cultural landscapes and the provision of a wilderness recreational experience."

This definition is intended to ensure that future management of the wilderness values of the TWWHA continues to protect those values through the restriction of built infrastructure and mechanical access while also allowing for Tasmanian Aboriginal people to enjoy access to Country, use of cultural resources and the opportunity to continue and re-establish cultural practices. The management of wilderness on this basis will also allow for the recreational experience it provides to be maintained.

The large extent of remote and largely undisturbed country forms the tangible component of wilderness value in the TWWHA. These areas are fundamental to the integrity of the TWWHA and many of the natural and aesthetic values that form part of its OUV. The scale and remoteness of these areas is also important in the protection of the Aboriginal cultural values contained within them.

The vast majority of the TWWHA is of very high to extremely high landscape wilderness quality. Wilderness mapping of the property was undertaken in 1995, 2005 and 2015. This long-term monitoring program has revealed that the landscape wilderness quality of the TWWHA has remained in very good, and generally stable condition over the period, with only minor localised changes detected. In 2016 approximately 76 000 ha was added to the Wilderness Zone of the TWWHA, although this is not a direct indicator of wilderness quality.

Wilderness quality can be viewed as a proxy for multiple indicators of condition of natural TWWHA values. If wilderness quality remains in good condition, we can be fairly confident that the integrity of the TWWHA and its OUV is being maintained.



MAP SHOWING AREAS OF HIGH WILDERNESS QUALITY

Snapshot — Water Quality

Metal Contamination of Lake Sediments

Researchers recently published a paper reporting high levels of lead, copper, arsenic and cadmium in sediments of four lakes in the property possibly as a result of historic mining activity in nearby Queenstown and Rosebery. Technical reviews of the research by both EPA Tasmania, and UTAS found the conclusions linking open-cut mining to metals in lake sediments were not supported by the data.

Previous studies involving sampling of invertebrates and fish from freshwater lakes within the property failed to demonstrate any adverse findings, indicating that the metal contaminants are most likely strongly bound in the lake sediments.

Environmental quality relating to back-country toilets

There have been ongoing efforts to improve the operation of back country toilets, in re-sponse to observed impacts on environmental quality. It has been discovered that the low ambient temperatures across the TWWHA mostly do not allow adequate wastewater-related evaporation or composting to occur. Therefore, composting toilets are gradually being replaced by sealed unit systems, whereby all the waste is flown (or driven) out of the national park.

LAKE SAMPLING FOR MACROINVERTEBRATES, AQUATIC VEGETATION AND WATER QUALITY

- Photo: NRE Tasmania

Water quality in Macquarie Harbour

Approximately one third of the area of Macquarie Harbour is located within the boundary of the TWWHA. Water quality in the harbour has been monitored under various programs with many years of data collected within the harbour and for shorter periods within the Gordon and King Rivers. The monitoring has shown evidence of deterioration in the environmental conditions in the harbour broadly, and also within the TWWHA region, with increased finfish aquaculture likely to be one driver of dissolved oxygen decline, but that other drivers exist, including organic load from freshwater inputs.

Benthic fauna sampling in 2016 and 2017 indicated a significant decline in the abundance and diversity of benthic species in the deep water sites within the TWWHA region of the harbour, as a result of low dissolved oxygen levels in the bottom waters. The low dissolved oxygen levels in the bottom waters has also led to an increase in the presence of the sulphur bacteria Beggiatoa. These same low oxygen levels appear to also be limiting for the endangered Maugean skate and presumably their prey, although the skate appears to often prefer a shallower depth range.

Baseline Water Quality and river health monitoring

Seventy seven per cent of sites sampled across the TWWHA showed macroinvertebrate diversity and water quality consistent with an undisturbed catchment, indicating healthy rivers. A further 11 per cent were more diverse than expected. Only 3 per cent of sites demonstrated a ‘significantly impaired’ waterway condition as a result of structures including dams.

Snapshot — Air Quality

Air quality - general

The prevailing westerly wind delivers very clean air, sometimes described as "one of the cleanest air sources in the world" that has travelled 17 000 km over oceans before meeting land on the West Coast of Tasmania.

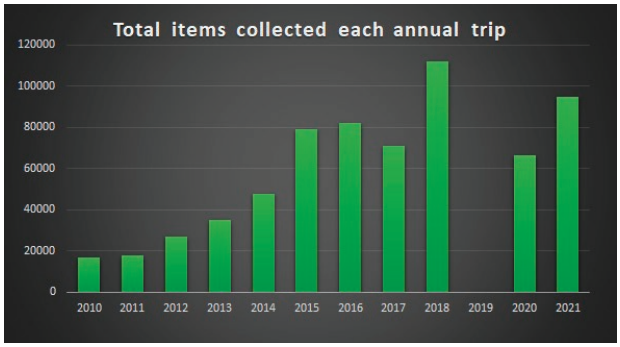
Air quality - smoke management

Smoke from controlled fuel reduction burns, which are conducted within and around the TWWHA, can cause significant impacts on environmental quality (and human health) on occasion. Smoke from bushfires can also be a major issue, with the increased number and/or size that have been experienced in recent years.

THE LARGE GELL RIVER FIRE THAT STARTED IN LATE DECEMBER 2018 AND KEPT BURING UNTIL FEBRUARY 2019 - *Photo: NRE Tasmania*

Snapshot — Litter

Facing the wild Southern Ocean, the south-west coast of Tasmania is battered by storms and wild weather, bringing with it a variety of rubbish and fishing equipment. Flotsam and jetsam litter has degraded habitat and wilderness values along the property's 300 km coastline. Since 1999, a beach clean up and monitoring program has been conducted by the Wildcare Coastal Custodians along the remote south coast beaches of the TWWHA. Volunteers travel to the remote beaches where they collect and catalogue the rubbish. The identification and recording of rubbish allows work to be done to reduce particular types of rubbish. The 2020 clean up retrieved 66 750 items over a nine day period and the latest clean up in March 2021 yielded 95 000 items, comprising mostly micro plastics. Over a 7 hour period, 18 people tackled a 50 metre section of beach focusing on micro plastics — pieces ranging from 2.5mm to 10mm and often dominated by nurdles.



Threats and their management

Although the Tasmanian Wilderness is a large and for the most part pristine area, a number of threatening processes are causing the deterioration of some of its values.

Whilst the list of current and potential threats is long, in part due to the wealth of information produced by our monitoring and research programs, our management responses to some of these threats have reduced the likelihood of damage to the values for which the property was inscribed. However, we remain vigilant to these threats and their consequences and additional measures might still need to be taken. Threats that fall into that category include climate change, uncontrolled bushfire and further spread of alien species (e.g. fallow deer), plant and animal pathogens (e.g. Phytophthora, chytrid disease).

GORDON RIVER SPEED LIMITS PROTECT THE SENSITIVE RIVER BANKS - *Photo: NRE Tasmania*

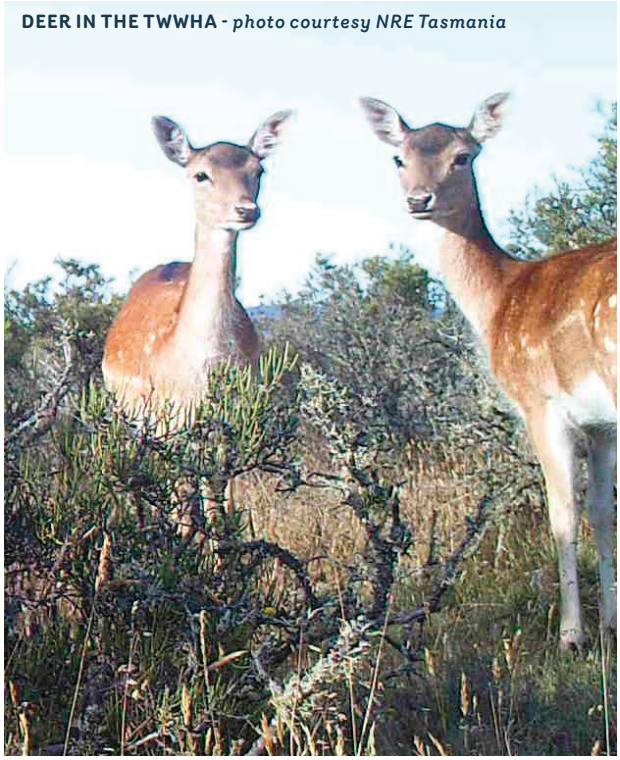
SEA SPURGE - *Photo: NRE Tasmania*

Bushfires, especially 'landscape-scale fires' (i.e. fires that are not stopped by normal fire boundaries such as wet forest or major rivers) as well as peat fires, are potentially a significant threat to high value ecosystems. The relative frequency of fires started by lightning has increased with dry lightning now the most common cause of fires in the TWWHA. Fires are now occurring in areas with no history of fire, threatening the ancient pines and other alpine flora that have survived for centuries without experiencing fire. Additional information about fire regimes and their ecological impacts on communities is of critical importance to management.

Plant diseases and dieback, especially that caused by the phythophthora dieback fungus, *Phytophthora cinnamomi*, is potentially a major threat. Previously prevalent along hiking trails, now with increased use and visitation coupled with logging and mining operations adjacent to the property, increased risk of spread of this fungus is possible. A *Phytophthora cinnamomi* management plan has been developed to mitigate the risk of further spread and management of the pathogen. In addition to Phytophthora, the introduction of Myrtle Rust into the TWWHA remains a high risk to the spectacular forest ecosystems.

Animal disease is also a concern, including wombat mange and chytrid — a fungal disease affecting frogs world-wide. Chytrid disease was first detected in Tasmania in 2004 and has been recorded from most areas of Tasmania except parts of the TWWHA. The disease is spread by movement of soil and water on machinery, boots and equipment.

Weed invasion is generally only a problem in areas of mechanical disturbance such as roadsides (e.g. blackberry) and along river banks. In coastal areas control of marram grass, pampas grass and sea spurge are underway. We continue to monitor reports of weed infestation in the TWWHA extension area where gorse, ragwort, broom, Canadian pond weed and holly are of potential significance.



DEER IN THE TWWHA - *photo courtesy NRE Tasmania*

Invasive animals pose a significant threat, especially established species such as trout, starlings, rabbits, European wasps and bumblebees. Efforts to remove feral goats from the property have been very successful.

Other invasive animals such as fallow deer, alter vegetation communities, cause erosion, hamper revegetation of native areas, and affect wilderness value, thereby posing a serious threat to the values of the TWWHA. The European starling which directly impacts Orange-bellied Parrots by using tree-hollow nest sites and by killing incubating females at nest, is being controlled in and around Melaleuca to help increase the survival rates of the Orange-bellied Parrot.

Geological values of the TWWHA are threatened by extensive erosion on the Central Plateau in the north-east of the property and by coastal erosion along the south-west beaches and dunes. River regu-lation by hydroelectric power generating operations are associated with unnatural erosion of lake and river banks, and degradation of other values. Increases in boat traffic in some sensitive locations can impact river banks and riverside vegetation and future climate may lead to increased river heights and ocean levels resulting in inundation and potential erosion.

WOMBAT SHOWING SEVERE MANGE WHERE ITCHING FROM THE MITE INFESTATION HAS LED TO FUR LOSS AND SKIN LESIONS
Photo: Kellie Lovell

Snapshot — Weeds

Weeds have the potential to significantly change and degrade native vegetation resulting in degradation or loss of natural values. In addition to this, some weed species are also environmental engineers which can change the nature of natural environments and processes. This latter category includes willows, marram grass and rice grass.

Currently, the majority of the TWWHA is largely weed free and a number of management programs have been successful in tackling priority weed issues in the past. The current distribution of invasive weeds within the TWWHA displays some distinct patterns often associated with roads, rivers and the coast. Roads are the most common conduits for weed movement in the TWWHA, reflecting many factors including the presence of disturbed substrates on road verges and batters; historical land management practices; poor hygiene practices with weed infested gravel; and poor management practices of roadsides being slashed in areas of known weed infestations and then entering weed free areas. Roads are often the places where the widest range of weeds can be found, with some species restricted to the edge of the roadside whilst others actively invade the neighbouring native vegetation. The latter active invaders include Spanish heath, blackberry, gorse, brooms, pampas, New Zealand sedge, and orange hawkweed.

The 2013 TWWHA extension added areas with both a recent history of disturbance and an extensive road network and which are closer to agricultural and settled landscapes. Therefore, along with increasing the natural values in the TWWHA, this 2013 extension has also increased the weed issues present within the property.

TWO VOLUNTEERS WEEDING SEA SPURGE FROM A BEACH FOREDUNE ON THE SOUTH-WEST COAST AS PART OF THE VOLUNTEER SPRATS PROGRAM - *Photo: Collette Harmsen*

Historical settlements or infrastructure are often weed nodes due to historical planting. Marakoopa Cave is an example of this where the historical plantings of holly and ivy are spreading into the surrounding forest.

Water is an excellent weed dispersal mechanism in the form of rivers, creeks, harbours, lakes, and the ocean, all of which have the potential to expand weed infestations in the TWWHA. These conduits have potential for the greatest impact on the integrity of the TWWHA because these infestations could proliferate without necessarily being noticed and control will be more difficult due to the remoteness.

There is about 850 km of coastline between Macquarie Harbour and Cockle Creek, with about 425 km of this coastline being considered susceptible to sea spurge and/or marram grass invasion. Both these weeds have decreased significantly in the TWWHA in recent years. This is primarily due to intensive action by the supported Wildcare Group SPRATS who began their work in 2006/2007 and every year since then, 25-70 volunteers have worked on Tasmania's south-west coast from Macquarie Harbour to Cockle Creek. Millions of sea spurge plants were removed each year between 2009 and 2014, eliminating the vast bulk of infestations along the coastline. In 2019/2020 only about 13 000 were removed and in 2020/21 53 700 plants were removed. In total, since the start of the program, some 14 350 000 sea spurge plants have been removed from the foredunes along the TWWHA coastline. Despite this improvement, the constant movement of propagules down the western coast from the northwest means ongoing management is necessary to maintain this current improved status. Without this active management it is reasonable to expect that infestations would increase once again.

Apart from Marakoopa Cave, weeds do not appear to be a major threat to TWWHA karst values. Depending on species and scale of infestation, weeds can alter natural hydrology and water quality in karst systems and make access to caves difficult. Weeds around cave entrances may affect their suitability as habitat for some cave-adapted species.

Many weed problems are shared with tenures adjacent to the TWWHA with some key species observed to spread across boundaries such as ragwort, which appears to have invaded the Central Plateau from the lowlands to the north, foxglove, blackberry, gorse, English and canary brooms, pampas and thistles.

Overall, consideration of the risk from weed infestation suggests species that are of most significance are those that may establish significant populations away from human infrastructure and can disperse readily within the TWWHA such as ragwort, blackberry, sea spurge, marram grass, pampas grass, and plants with bird dispersed seed such as holly, and Elisha's tears.

In addition, the increasing occurrence of wide scale fire events poses a concern for weed management. These events increase the likelihood of weeds establishing in disturbed areas and the likelihood of wind dispersed species such as ragwort and thistles colonising remote areas.

Snapshot — Enhanced Fire Management

The installation of two new weather stations will greatly assist fire management staff to both plan for, and conduct, prescribed burns. Weather 'intelligence' during a fire event will also be dramatically improved. The up-to-date data sourced from remote stations at Low Rocky Point and Scotts Peak, will improve forecast predictions.

The locations were chosen to fill gaps in available weather data from across the TWWHA. Selecting the appropriate site is important as the station needs to be representative of conditions in the area and not obstructed by trees, crags or peaks. The new stations will report weather 'intelligence' every ten minutes, transmitted via satellite.

The installation of these new stations was a recommendation of the 2016 Tasmanian Wilderness World Heritage Area Bushfire and Climate Change Research Project.

Accurate weather data assists in protecting the OUV of the TWWHA from fire by increasing opportunities for planned burning and providing important information on weather conditions during a bushfire.

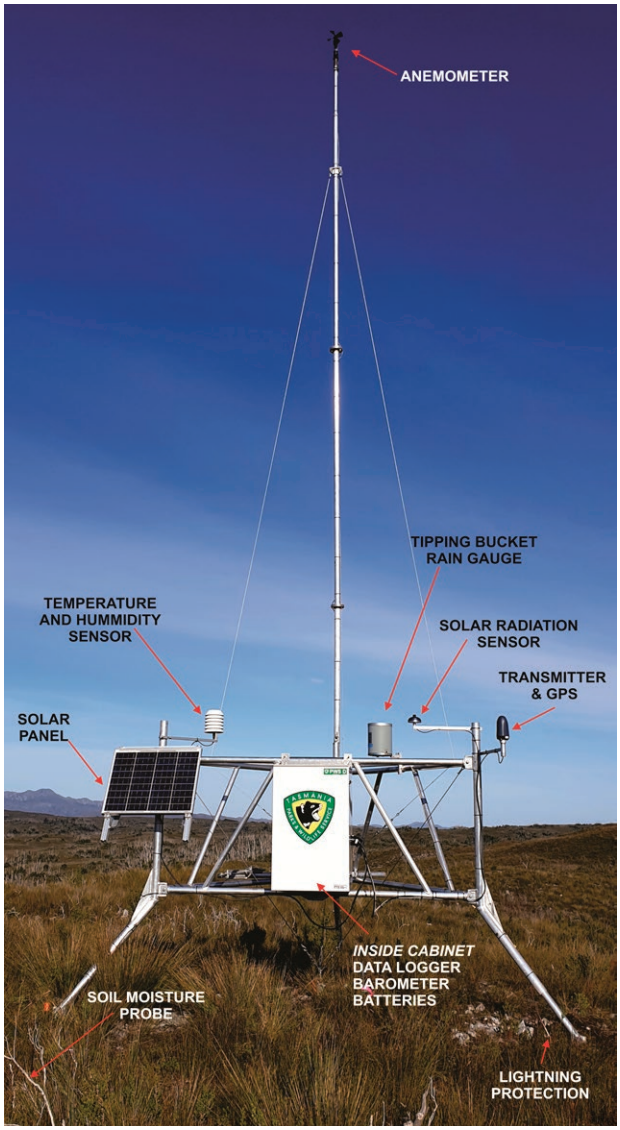
When it comes to planned burning, weather is crucial and it's not only for the day of the burn. For each planned burn, fire management officers prescribe conditions for the introduction of fire. This includes an identified temperature range, rainfall, wind speed, direction and soil moisture - to ensure the set objective is met and the burn is manageable.

Knowing the weather in the lead up to the burn helps to determine the state of the fuels - within and adjacent to the planned burn. The weather conditions on the day are then monitored to ensure they are suitable to undertake that particular burn.

As well as the benefits from these new weather stations, in partnership with the Tasmania Fire Service and the Victorian Government's Arthur Rylah Institute for Environmental Research, we are also developing a readily useable fire severity mapping tool for Tasmania.

Robust fire severity mapping is critical for understanding the impacts of fire on natural, cultural and economic values. For natural values, severity mapping will allow rapid assessment of where fire has affected fire-sensitive values and unburnt refugia. This will inform prioritisation of detailed assessments on-ground, and more timely planning and initiation of conservation actions.

Victoria and NSW have recently adopted a severity mapping approach that utilises Sentinel satellite imagery and a machine learning-derived algorithm to 'automatically' produce severity maps. This approach allows highly accurate severity maps to be produced in minutes and updated every few days as the Sentinel satellite/s passes overhead. This represents a major advance on 'traditional' manual mapping of fire impact severity. We commenced using this approach mid-2021 and are currently fine tuning it to best meet our fire management needs.

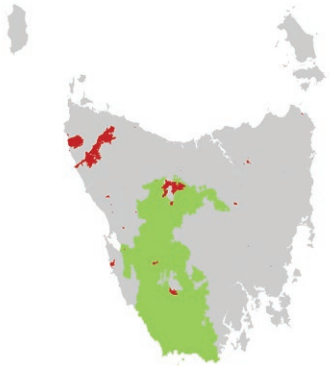


PWS AUTOMATIC WEATHER STATION SHOWING TOWER AND ASSOCIATED MONITORING EQUIPMENT - *Photo: Cassidy Newland*

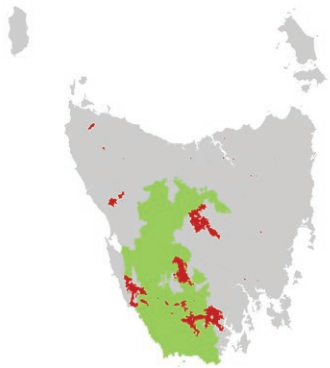
Organic soils pose a significant problem to fire managers, as they are both a fire sensitive feature contributing to the OUV, and a fuel that once ignited, is extremely difficult to extinguish. Fire in peat leads to costly and dangerous suppression efforts, and causes significant and permanent eco-system change in a single event.

The Department has developed an organic soil location map for the TWWHA. In addition, the Department is working with the University of Tasmania to understand how soil moisture controls peat flammability, and how moisture varies across the soil landscape. This information will improve prediction of fire behaviour, offering improvements in prioritising fire suppression efforts and in modelling of fire behaviour, as well as better awareness of risks to fire crew safety.

Bushfires can cause significant damage to fire sensitive natural values. They can also initiate ongoing degradation processes, which can continue to degrade the remaining values for extended periods.



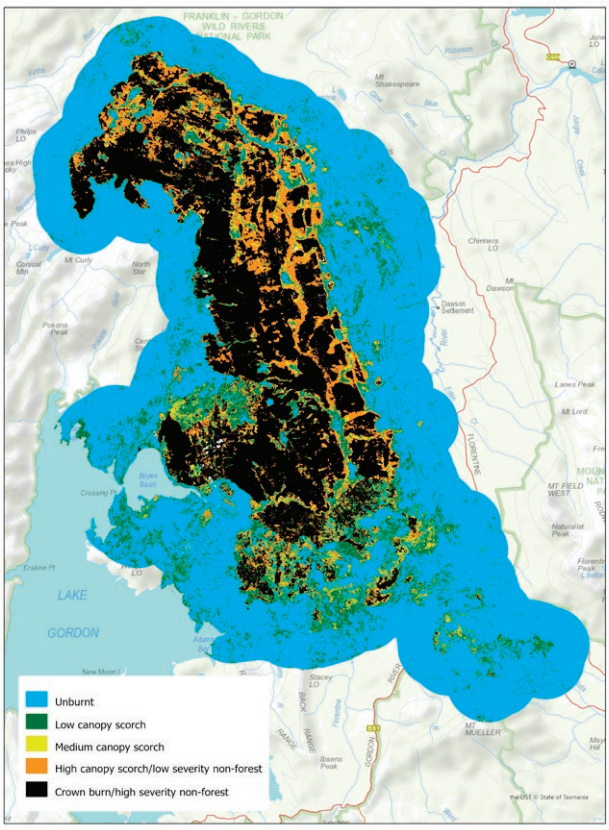
Summer 2015/16 fires



Summer 2018/19 fires

LOCATION OF BUSHFIRE AFFECTED AREAS (RED AREAS) IN 2015/16 AND 2018/19 IN RELATION TO THE TWWHA (GREEN AREA)

FIRE SEVERITY MAP FOR GELL RIVER BUSHFIRE AT 15TH JANUARY 2019. MAP PRODUCED BY FIRE SEVERITY MAPPING TOOL CURRENTLY IN DEVELOPMENT



Monitoring of fire damage is needed to understand the magnitude of fire impacts, the potential for natural recovery and requirements for rehabilitation. Immediate post fire assessments provide some of this information, but while some damage is apparent immediately post fire, other aspects are revealed over time (e.g. the slow death of fire damaged plants, or the establishment of ongoing erosion processes).

Where there is some combination of severe fire damage, ongoing fire initiated degradation and a lack of natural recovery, a rehabilitation intervention may be justified. This can significantly improve either the rate of recovery, or the final outcome for the damaged area. Damage caused to alpine areas, such as occurred in 2016 around Lake Mackenzie, is an excellent example of where this type of intervention may be justified.

As our knowledge of fires, their extent, intensity, frequency, and values impacted increases, we will be better placed to understand the changing climate and the flammability of the landscape at any particular time, and the expected outcomes from a bushfire. This information also tells us how best to respond, both at the time and after the event, and when rehabilitation may be an option.

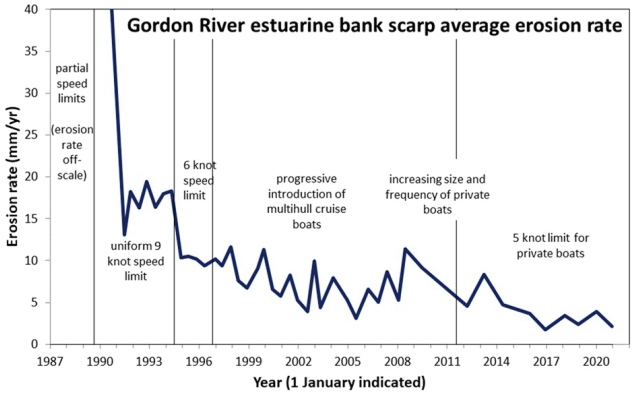
Snapshot — Gordon River erosion

The lower Gordon River has a long-standing problem with bank erosion caused by vessel generated waves. This started in the 1980s, when publicity generated by the Gordon below Franklin dam controversy led to increased visitation and the introduction of large, high speed cruise boats that produced a very substantial wake. Highly energetic waves do not naturally occur in the deeply sheltered valley of the lower Gordon.

The most obvious sign of the problem was the sudden toppling of many mature myrtles and ancient Huon pines - trees which had contributed to the OUV identified in the 1982 World Heritage Area listing. That treefall event ripped apart a root mat that would otherwise have provided protection against more modest wave attack. Despite subsequent sapling regrowth, all lower Gordon River banks remain unnaturally susceptible to erosion by waves in the absence of a mature root structure.

More than three decades of monitoring and geomorphological investigations have informed management actions aimed at controlling the erosion problem. Experiments have determined the threshold of erosion on the muddy banks that line the lower reaches. Commercial cruises operate a low speed to keep their wave energy below that threshold. The sandy banks further upstream will more often than not erode with even the smallest of waves and only very limited commercial boating activity is permitted there.

The present monitoring program measures the rate of erosion at some 40 sites. The graph shows that successive management actions, chiefly the introduction and revision of speed limits, have caused a gradual slowing of the erosion rate. Near bank turbidity (water cloudiness due to suspended sediment) is continuously monitored at two sites. These record the passage of boats that cause bank erosion.



RESEARCHERS STUDYING IMPACTS OF BANK EROSION IN THE TANNIN STAINED BLACK WATERS OF THE GORDON RIVER - *Photo: Grant Dixon*

Snapshot — Climate Change vulnerability

Climate change has been recognised as the single greatest threat to biodiversity due to the rate, scale and geographic extent of its predicted impacts, and is therefore one of the major threats to natural World Heritage Areas globally. Climate influences most natural processes at the Earth's surface, including fire regimes, soil development and the erosion and deposition of sediment. In combination with factors, such as competition, history and disturbance regimes, climate regulates the distribution of species and communities. Climate change is already impacting the natural values in the TWWHA through increasing environmental stresses including the rapidly changing threat posed by bushfire. The climate trajectories modelled for Tasmania will cause landscape scale change in the natural systems of the TWWHA over the coming decades, and potentially these changes will be rapid and significant.

In comparison to most protected areas globally, the TWWHA has excellent potential for landscape scale ecosystem resilience due to its combination of very large size, natural integrity and diverse and complex geography. These factors create opportunities for some natural values to adapt autonomously to climate change, a process whereby ecological communities will change in extent and composition, with some becoming rarer whilst others expand. However, some of the TWWHA's natural values are clearly vulnerable to damage and loss in the absence of timely planning and management intervention. For others it is likely no practical management options will be available with complete loss or irreversible change being the ultimate outcome.

In the TWWHA, species and communities highly vulnerable to climate change are concentrated in alpine and freshwater ecosystems, as well as the globally unique estuarine community in Port Davey-Bathurst Harbour. These environments contribute to the OUV of the TWWHA, containing high levels of endemism and high representation of primitive, relictual or Gondwanan species. Overall, climate change is predicted to have significant and adverse impacts on many of the values that are unique to the TWWHA.

INSTALLING AN AUTOMATIC WEATHER STATION ATOP MT SPRENT AS A HELICOPTER USED TO OFFLOAD THE RESEARCHERS AND EQUIPMENT, FLIES PAST, WITH LAKE PEDDER VISIBLE IN THE DISTANCE - ***Photo: N Fitzgerald***

The capacity to assess and manage risks and impacts associated with climate change is dependent on our ability to make informed decisions and implement effective management strategies. To work towards this goal, progressive assessment of risk and impacts of climate change in the TWWHA has been developed over the last decade. Risk assessments have been undertaken and some baseline environmental monitoring of vulnerable values established. Several automatic weather stations and arrays of data loggers collecting environmental variables have also been maintained, with collected data feeding into impact and climate modelling work.

To tackle the challenge, we have developed the *Tasmanian Wilderness World Heritage Area Natural Values Climate Change Adaptation Strategy 2021-31* that lays out a framework to increase understanding of vulnerabilities and adaptation pathways, with a focus on delivering practical information, actions and tools to manage risks and reduce impacts. A three layered management approach to natural values climate change adaptation underpins the Strategy:

1. Plan for long term landscape-scale ecosystem resilience.
2. Manage overarching processes and threats which compound the increased stressors from climate change (biosecurity, bushfire etc.)
3. Better understand vulnerable values, assess their limits, thresholds and tipping points, and devise management tools to improve long term outcomes.

Snapshot — Introduced animals

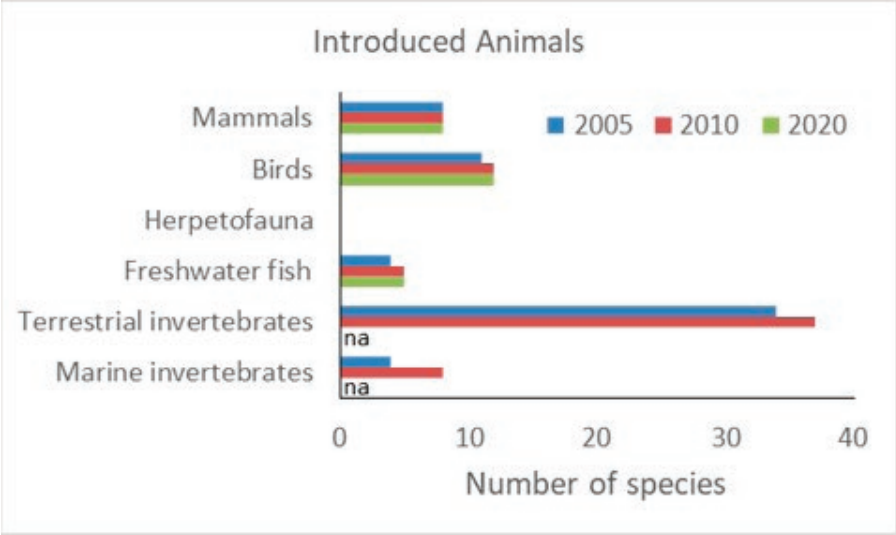
In 2005, the TWWHA was inventoried for introduced vertebrate and invertebrate fauna. That inventory found that the TWWHA was characterised by low numbers of introduced species with established populations. These low numbers ensured that for most of the property, the native fauna were safe from significant impacts of these introduced species.

In 2010, a comprehensive review and risk assessment of introduced species was completed documenting 25 species of vertebrates (8 mammals, 12 birds and 5 freshwater fish) in the TWWHA. Of these, five species appeared to have established a significant presence in the TWWHA: feral cat, European rabbit, sugar glider, lyrebird, common starling and brown trout.

There were also 37 non-marine and eight marine invertebrate species identified in the review. Most non-marine invertebrates were confined to circumscribed localities of human disturbance and only four species appeared to be widespread within the TWWHA: honeybee, European wasp, bumblebee and hedgehog slug. All documented introduced marine invertebrates had a restricted distribution within the Port Davey estuary although the data is sparse given the need for underwater surveys.

In the 10 years since 2010, there has been no known increase in the number of introduced vertebrates in the TWWHA. However, species such as the Superb lyrebird and the fallow deer have increased their range within the TWWHA over that time.

GRAZING FALLOW DEER CAPTURED BY A REMOTE CAMERA
- Photo: NRE Tasmania



Our knowledge of the risk and impacts of introduced animals on biodiversity conservation is limited to a few threatened species but is improving. Evidence for widespread and significant impacts of an introduced animal is most persuasive for brown trout. In 2009 a survey of large coastal river catchments of the south-west of the TWWHA between Cape Sorell (Macquarie Harbour) and South East Cape found them to be free of trout (except New River) and of high conservation value. Impacts have also been documented for European rabbits, common starlings, European wasps, honeybees, goats and lyrebirds. Studies are currently underway into the spread and impact of fallow deer in the TWWHA.

A review of the status of introduced species and their risk has been recommended as part of a Biosecurity Strategy for the TWWHA.

TAKING MEASUREMENTS OF TRAPPED FAUNA - *Photo: Tim Rudman*

Future Intermediate Performance Reporting

As our data improve over time, we will be in a position to bring on-line, a range of management performance metrics that will enable us to better track the condition of the natural values of the TWWHA and how our adaptive management approach is influencing changes that we are seeing in the condition.

For those values where we are currently reliant upon expert opinion for either our assessment of condition or understanding of trend in that condition, this increasing level of data will help solidify our knowledge and understanding and hopefully correlate well with that expert thinking.

To assist with future status and trend reporting of natural values, we are proposing the following sets of intermediate (next ten years) metrics. We are not expecting each and every one of these to be immediately adopted but rather over time see a staged uptake of these metrics with planned monitoring. This data availability will not only inform these intermediate condition targets but also inform the KDOs and management actions of the Management Plan and our Key Evaluation Questions that underpin the Monitoring and Evaluation Framework for the TWWHA.

The metrics that follow are value aligned. We have used expert opinion to set an intermediate (2030) target score based on current knowledge or opinion on how we are currently performing and the expected condition at 2030 should the current TWWHA Management Plan actions continue. Adopting any of these proposed metrics will require an ongoing commitment to future monitoring but given the international significance of the TWWHA we are confident that such monitoring can be part of any ongoing adaptive management strategy for the property.

The intermediate condition target score icons should be interpreted as follows.

Intermediate Condition Target Score

- Good
- Good with some concern
- Significant concern
- Unsatisfactory

Current ability to measure target

✓✓ Moderate to high level of evidence – knowledge of attribute is such that there is confidence in the achievement of the target within next 10 years based upon current management action and level of monitoring and investigations underway or planned

✓ Low to very low level of evidence – a paucity of knowledge about the attribute means that whilst there is an expectation that the condition target can be achieved within 10 years, there is currently little or no monitoring occurring or planned to inform any success

Proposed intermediate Condition Metric

Vegetation

> No reduction in priority paleo-endemic flora sites	✓✓
> No reduction in number, extent and condition of snow patch ecosystems	✓
> No reduction on 2014 map baseline of feldmark	✓
> Montane grassland area maintained or increased	✓✓
> Composition, structure and diversity of montane grassland vegetation improved	✓✓
> Conifer health score maintained	✓✓
> No loss of Giant Trees due to unnatural events	✓✓
> Sphagnum cover and growth maintained	✓
> Area of fire sensitive vegetation burnt	✓✓
> Condition of vegetation communities is maintained via appropriate fire regimes	✓
> Persistence of threatened plant populations	✓
> Condition and extent of treeless alpine vegetation maintained	✓

Animals

> Number of native vertebrate species maintained	✓✓
> Number of primitive and relict animal species maintained	✓
> Number of animal species that are threatened maintained (or reduced due to a reduction in threat)	✓✓
> Composition of Bathurst Channel marine invertebrate community maintained	✓✓
> Wild populations of Tasmanian devil (endangered, endemic), spotted-quoll (vulnerable) and eastern quoll (endangered, endemic) maintained and healthy	✓✓
> Wild population of Orange-bellied Parrot (critically endangered, endemic) breeding maintained or improved	
> Populations of Pedder Galaxias (endangered, endemic), Clarence Galaxias (endangered, endemic), Swamp Galaxias (vulnerable, endemic) and Western Paragalaxias (rare, endemic) maintained or improved	✓
> Populations of Maugean skate (endangered, endemic) are maintained or improved	✓
> Glow-worm populations maintained in Exit and Mystery Creek Caves	✓✓
> Maintenance or improvement in the distribution or abundance of native animal species declining due to impacts from introduced animals or diseases	✓
> Area of waterway free of brown trout and other introduced fish species is not increasing	✓
> Number of native, endemic species maintained	✓✓

Proposed intermediate Condition Metric

Beaches & Dunes

> Beaches and dunes retain their natural form	✓

Soils

> Reduced impact from vehicular and foot traffic in fragile soil landscapes	✓
> No increase in area of exposure of mineral soils to degrading processes.	✓
> Fire regimes appropriate to the vegetation type are maintained across the property.	✓✓
> No exposure of dry organic soils to fire	✓✓
> No human disturbance of acid sulfate soils	✓

Estuaries

> Marsupial lawn, saltmarsh, swamp forest and associated coastal communities distribution and area maintained	✓
> No significant loss of marine species in Port Davey / Bathurst Harbour	✓
> No significant loss of salt marsh and other soft sediment landforms	✓✓

Caves & Karst

> No loss or degradation of values	✓
> catchment integrity	✓
> maintenance of natural processes, rates and magnitude of change	✓

Fossils & Minerals

> no degrading loss of collectables such as rare minerals and fossils	✓

Invasive animals, plants & disease

> Mapped weed distribution maintained or improved at 2020 baseline	✓
> Fallow deer ingress controlled at 2020 baseline	✓
> *Phytophthora cinnamomi* mapped spread maintained at 2020 levels	✓
> Percentage of mapped trout free waters increased over 2009 baseline	✓
> Mange-free status of wombat population maintained	✓
> Devil facial tumour disease incidence maintained at 2020 baseline	✓
> Frog chytrid disease incidence maintained at 2020 baseline	✓

Proposed intermediate Condition Metric

Environmental Quality and Aesthetics

> Mapped wilderness quality maintained or improved against 2015 baseline	
> Viewfield experience maintained in unburnt areas	✓
> Water quality of rivers maintained at 2009 levels	
> Water quality of large lakes maintained at 2009 levels	✓
> Heavy metals in lake sediments remain bound and unavailable	
> Compliance of sewerage systems in accordance with licence conditions	✓
> Soundscape of the TWWHA maintained at 2020 baseline	
> Lighting guidelines ensure dark skies maintained at 2020 levels	✓

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