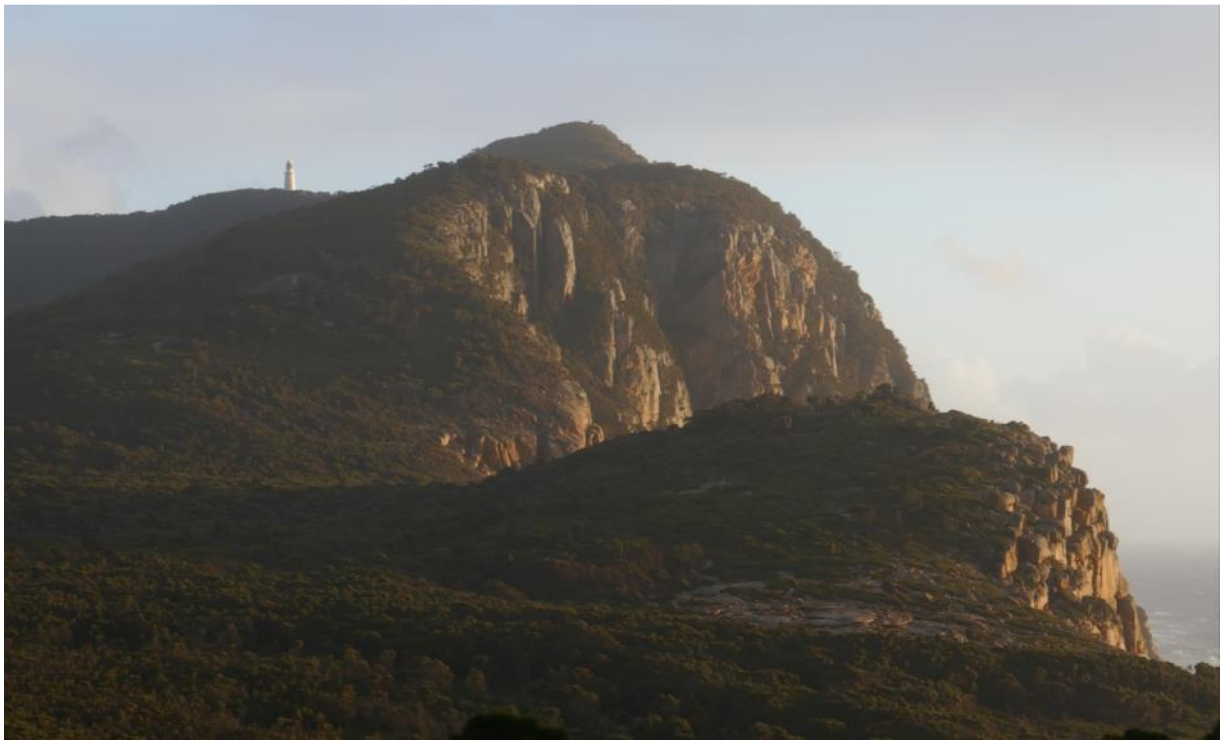
Deal Island volunteer caretaker report: summer 2021-22



Jon Marsden-Smedley
Gabby Whitworth
28 February 2022

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Sea mist rolling into Squally Bay

1 Summary

This report summarises the caretaker jobs and activities performed by Jon Marsden-Smedley and Gabby Whitworth whilst acting as volunteer caretakers for the Parks and Wildlife Service on Deal Island over the 2021-22 summer. The primary aim of the report is to provide a resource document. The main topics covered are:

- caretaker jobs performed;
- vegetation mapping on Deal, Erith and Dover Islands;
- surface, near-surface, elevated, bark and overall fuel hazard on Deal, Erith and Dover Islands;
- fire history on Deal Island;
- weed mapping on Deal Island;
- assessment of rare and/or threatened communities and species on Deal, Erith and Dover Islands;
- bushfire risk assessment on Deal Island;
- wildlife monitoring on Deal Island, and;
- other activities performed on Deal Island.

Over the 2021-22 summer, 77 boats, three Erith mob groups, one bushwalking party and one cruise ship were recorded. In total, 297 people were counted with the actual number being between about 350 and 375. The average stay was three nights.

The vegetation and fuel hazards on Deal, Erith and Dover Islands have been mapped. The vegetation change mapping indicated that rapid vegetation change is occurring on Deal and Erith Islands. Over the 38 years between 1982 and 2000, grasslands on Deal and Erith Islands respectively have reduced in area by about 65% and 77%. At the current rate, the majority of the Deal Island's grassland could be lost within 25 to 50 years and Erith Island's grassland within 15 to 25 years.

The major weeds on Deal Island are ragwort and sea spurge. Ragwort is the most critical weed and is rapidly spreading through the island's grasslands and grassy she-oak woodlands. Introduction of biological agents is the only feasible strategy for controlling ragwort. Sea spurge is a significant problem at East and Garden Coves with significant effort required for its control. Provided its efficacy is proven, consideration should be made regarding the release of the sea spurge biocontrol on Deal Island. A total of one arum lily, one great mullein and 15 sea spurge sites have been classified as major sites and require weeding at three month intervals. This weeding of major sites will require about one day's work at East Cove and two day's work at Garden Cove. All of the other target weeds are under control.

A total of four rare vegetation communities have been mapped by TasVeg in the Kent Group. All of these vegetation types have been either incorrectly mapped or their areas do not reflect their occurrence on the ground. None of the vegetation types mapped by this project would be classified as threatened. A total of 18 plant and four animal rare or threatened species have been recorded from the Kent Group. With the exception of Papery goosefoot (which is probably extinct), all of these species either occur in fire prone environments, areas containing natural fire refuges or in areas unlikely to burn. In addition to the listed rare and threatened communities and species, the issue of the rapid vegetation change on Deal and Erith Islands needs to be considered due to the potential for species relying on grasslands to be adversely impacted by the loss of grassland area.

A bushfire risk assessment has been conducted on Deal Island which indicated the current bushfire risk to people and cultural values was extreme and the risk to environmental values was medium. With a few easy to implement changes, including improved weather monitoring, caretakers and the public notifications, changes to work practices and signage, the bushfire risk to people and cultural values could be reduced to medium and the bushfire risk to environmental values to low.

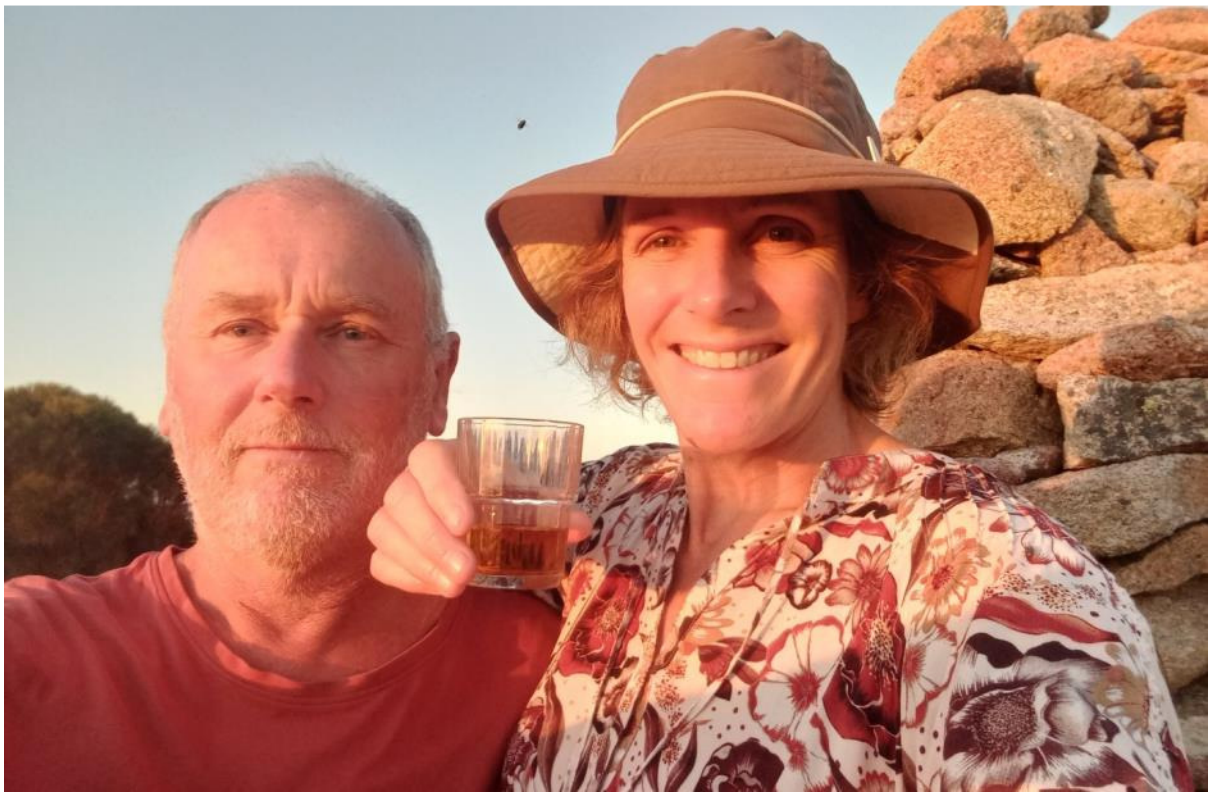
2 Report aims and scope

This report summarises the caretaker jobs and activities performed by Jon Marsden-Smedley (JMS) and Gabby Whitworth (GW) whilst acting as volunteer caretakers for the Parks and Wildlife Service (PWS) on Deal Island over the 2021-22 summer.

The Kent Group is located in central Bass Strait and comprises three main islands, Deal Island (1576 ha), Erith Island (323 ha) and Dover Island (295 ha), along with a number of smaller islands. It is Tasmania's newest, smallest and most remote national park. This report covers the park's main three islands (Maps 1 and 2).

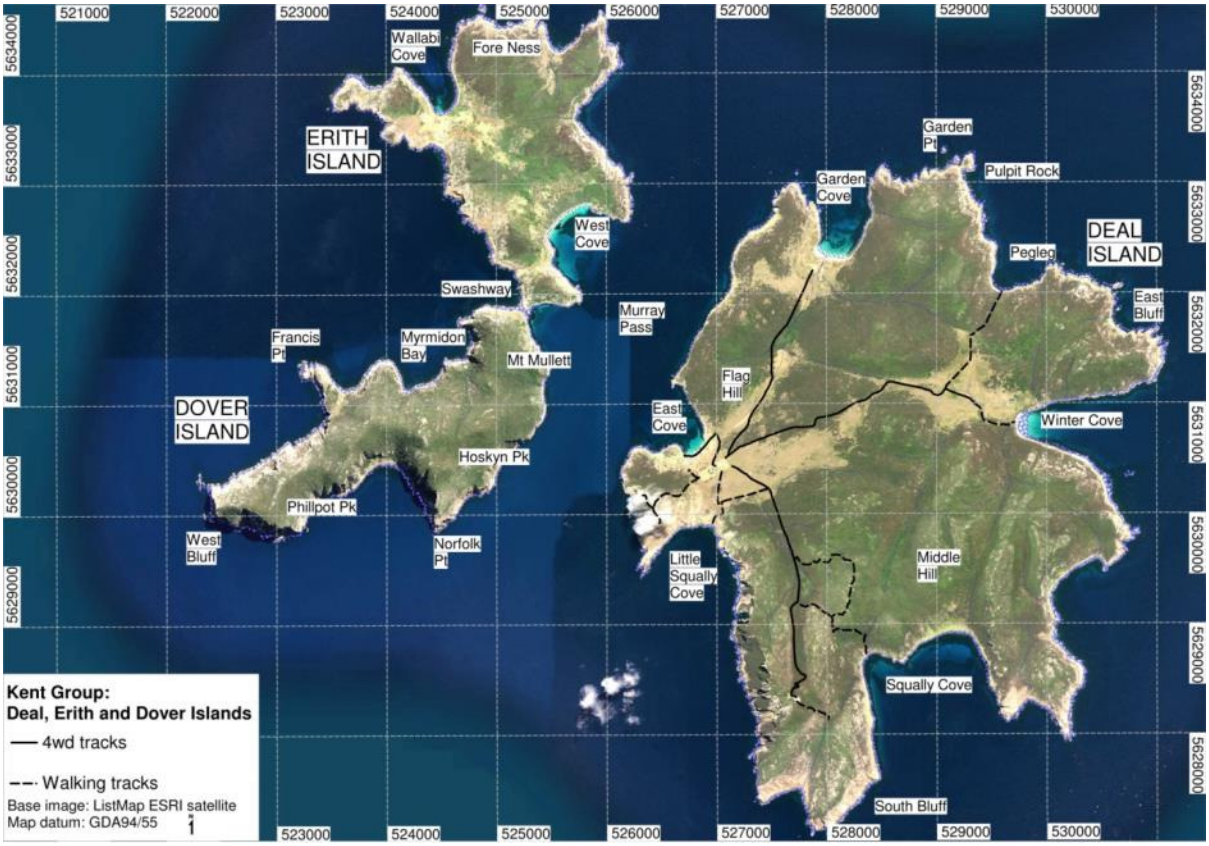
The primary aim of the report is not to provide detailed land and fire management recommendations, but rather to provide a resource document for the PWS, Friends of Deal Island WildCare group (FODI)[1] and future caretakers.

In performing the work in this report, full acknowledgement is made of the work performed by the FODI and the assistance provided by Department of Natural Resources and Environment Tasmania (NRE) staff involved, including Roger Ling and Steve Billingham in the PWS head office, Jayne Balmer in NRE and the Furneaux Island Field Centre Jesse Williams, Cindy Pitchford and Dominique Couzens

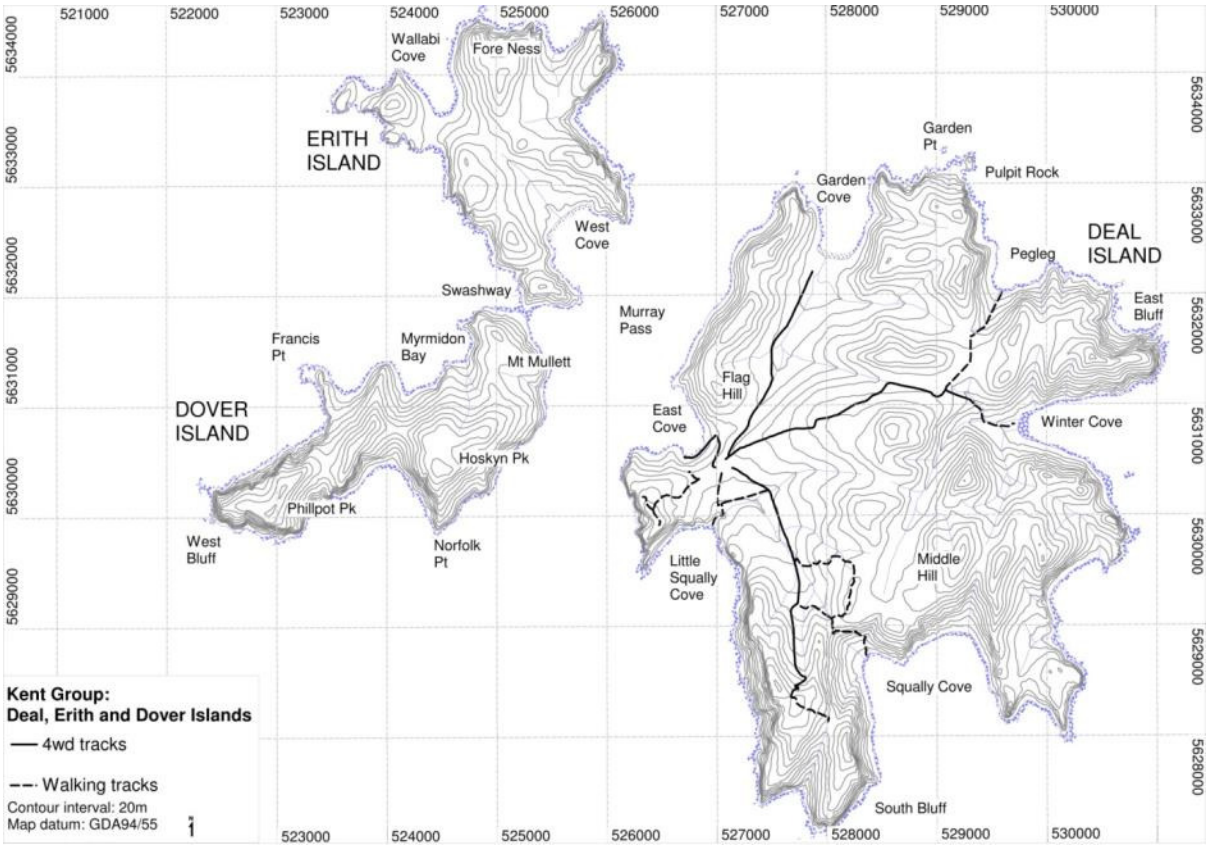


Jon and Gabby on Barn Hill on new year's eve

[1] WildCare Incorporated. Volunteer arm of the Tasmanian Parks and Wildlife Service. See: http://wildcaretas.org.au/



Map 1. Kent Group: ListMap ESRI satellite. Place names from the Tasmanian nomenclature list.



Map 2. Kent Group: Contours. Place names from the Tasmanian nomenclature list.

3 Information sources and background information

This report covers islands in the Kent Group National Park, including Deal Island, Dover Island and Erith Island.

The main caretaker duties and responsibilities are covered in the Deal Island handbook[2].

3.1 Mapping data

3.1.1 Base data

Coastline, contours and drainage data was obtained from the PWS in digital format and has been used in the MapInfo Geographic Information System (GIS).

The location of vehicle tracks, walking tracks, walking routes, fencelines, assets and historical sites (eg graves, cairns and whims) were mapped by JMS in November 2015, February 2016 and during the current caretaker period.

When field surveying was performed, information was recorded using a hand-held map-enabled GPS with notes being made in a field notebook. In November 2015 and February 2016 a Garmin Etrix30 GPS was used. During the current caretaker period, JMS used a Garmin 66i GPS and GW used a Garmin Etrix30.

All mapping in this report uses the GDA94 zone 55 (GDA94/55) datum.

High resolution pdf format versions of the maps in this report are available.

3.1.2 Aerial photographs and satellite images

All of the available aerial photographs and satellite images for the Kent Group that were on the NRE GIS system were used. In addition, a single aerial photograph taken by the National Safety Council of Australia, Victorian division (NSCA) on 27 November 1986 was found in the NRE Deal Island fire file (see below).

Table 1 shows the aerial photographs and satellite images that were used.

Note that aerial photographs were taken of the Kent Group prior to 1982 but these images are unavailable.

The latest state ortho-photograph and ESRI satellite image were downloaded at the maximum resolution from the ListMap website[3]. The ListMap satellite image was registered in the GIS using a one kilometre GDA94/55 grid while the Spot satellite image was supplied as a geo-referenced ECW format image. The remaining aerial photographs and satellite images were registered in the GIS using the ListMap satellite image as a reference.

Due to their large file sizes (~15 GB in total) digital copies of these images were downloaded prior to going to Deal Island.

Evening view from the lighthouse

[2] Deal Island volunteer caretakers program handbook. October 2021. Parks and Wildlife Service, Tasmania.

[3] ListMap: https://maps.thelist.tas.gov.au/listmap/app/list/map.

Table 1. Kent Group aerial photographs and satellite images.

Date	Type	Pixel size	Scale	Film
06/02/1982	black and white aerial photograph	0.7 m	1:40000	0904 - 156, 159
27/11/1986	colour aerial photograph	0.6 m	unknown	unknown
16/02/2000	colour aerial photograph	0.6 m	1:48000	1325 - 46, 47
04/09/2007	colour aerial photograph	1.0 m	unknown	unknown
19/07/2010	Spot satellite	2.0 m	-	-
29/03/2012	colour aerial photograph	0.3 m		1471 - 98, 107, 187, 199
30/09/2016	Google Earth	1.0 m	-	-
12/11/2020	ListMap ESRI satellite	1.3 m	-	-

3.1.3 Data collected and map files produced

Copies of all of the raw and collated field and map data have been lodged with the PWS (Appendix 1).

3.2 Historical information

Information on past vegetation distributions and bushfires held in the Deal Island museum and caretakers house were assessed.

The historical images were scanned and included photographs taken by:

- Field Naturalists Club of Victoria during their visit to the Kent Group November 1890;
- panorama taken from the lighthouse in 1976 showing areas burnt by the 1972 fire, and;
- Lionel Lawrence of the Commonwealth Lighthouse Service, Australian Maritime Safety Authority in 1995 showing areas impacted by the 1994 fire.

3.3 NRE file records

Information on past fire management was obtained from the NRE file:

- *502741 - Parks and Reserves management - property - landscaping and vegetation - Deal Island.*

This file contained information on the November 1986 National Safety Council of Australia, Victorian division (NSCA) fire and the October 1994 rubbish tip fire along with some very limited information on other fires.

3.4 Vegetation mapping

Common species names have been used where available in this report with the scientific name being included when the species is first used.

3.4.1 Previous vegetation mapping

Historical information on the distribution of different vegetation types was obtained from the mapping performed on Deal Island by Harris and Davis (1995)[4] and Dover and Erith Islands by Kirkpatrick (1995)[5]. Scanned copies of the vegetation maps in these references were registered in the GIS and digitised.

The TasVeg map[6] was used to make an initial assessment of the potential range in vegetation types. However, due to the TasVeg map's low accuracy, poor

[4] Harris S and Davis G 1995. The vegetation and flora of Deal Island, Kent Group. Papers and Proceedings of the Royal Society of Tasmania 129: 43-51.

[5] Kirkpatrick JB 1995. The vegetation Dover and Erith Islands, Kent Group, Bass Strait. Papers and Proceedings of the Royal Society of Tasmania 129: 25-33.

[6] Kitchener A and Harris S 2013. From Forest to Fjaeldmark: Descriptions of Tasmania's Vegetation. Edition 2. Department of Primary Industries, Parks, Water and Environment, Tasmania.

Note that a digital copy of the latest TasVeg live map was supplied by the NRE.

discrimination of vegetation type along with its overly complex and arbitrary classification of vegetation, the TasVeg map was not used to map the vegetation in this report.

Information on the listed distribution of flora and fauna species was obtained from the Natural Values Atlas[7].

3.4.2 Current vegetation and fuel mapping

The fire-attributes vegetation mapping system developed by Pyrke and Marsden-Smedley (2005)[8] was used to differentiate the different vegetation associations when the map of current vegetation types was developed. The aim of the vegetation mapping system developed by Pyrke and Marsden-Smedley (2005) was to group vegetation into structural and floristic types which respond to fire in a similar manner, simplifying and resulting in a more operationally applicable vegetation map.

The vegetation association types mapped on Deal, Dover and Erith Islands follow the structural types of Specht (1970)[9].

This vegetation map was developed using on-screen mapping, mainly from the 2020 ListMap ESRI satellite image, with some areas being checked against the 2012 ListMap colour aerial photograph (Table 1).

The mapped vegetation types were checked using ground surveys.

When ground surveys were performed, the vegetation and fuel strata characteristics were recorded using the fuel hazard assessment system developed by JMS. This system has been based on the Victorian fuel hazard assessment system[10] with modifications to make it operationally practical and applicable to Tasmanian conditions (see Box 1; Marsden-Smedley et al. in prep 2022)[11].

The fuel data collected is summarised in Table 2.

View from Barn Hill, Deal Island

7 Natural Values Atlas. Department of Primary Industry, Parks, Water and Environment, Tasmania.

8 Pyrke AF and Marsden-Smedley JB 2005. Fire-attributes categories, fire sensitivity, and flammability of Tasmanian vegetation communities. TasForests 16: 35-46.

9 Specht RL 1970. Vegetation. In: The Australian Environment. CSIRO and Melbourne University Press.

10 Hines F, Tolhurst KG, Wilson AAG and McCarthy GJ 2010. Overall fuel-hazard guide. 4th edition, Report 82, Fire Management Branch, Department of Sustainability and Environment, Melbourne, Victoria.

11 See: Marsden-Smedley JB, Anderson WR and Pyrke AF. In prep 2022. Fuel in Tasmanian dry eucalypt forests: prediction of fuel hazard rating and fuel load.

Table 2. Vegetation and fuel data collected during vegetation surveys.

Strata	Data collected	Units
Vegetation type	canopy species	type, cover, % and height, cm
	second stratum species	type, cover, % and height, cm
	ground stratum	type
Surface fuel	cover	%
	depth (height)	cm
	surface fuel hazard rating	L, M, H, VH or E
Near-surface fuel	cover	%
	height	cm
	dead fuel	%
	near-surface fuel hazard rating	L, M, H, VH or E
Elevated fuel	cover	%
	height	cm
	dead fuel	%
	elevated fuel hazard rating	L, M, H, VH or E
Bark fuel	type	candle, fibrous or other
	bark fuel hazard rating	L, M, H, VH or E
Overall fuel	overall fuel hazard rating	L, M, H, VH or E
Fuel load	visual estimate of amount	t/ha
Easting and northing	grid reference	GDA94/55
Photographs	camera reference numbers	
Notes	other site information such as rock or soil cover	

Bushwalking down Deal Island's western ridgeline

Box 1: Fuel hazard rating

Prior to about 20 years ago, the term *fuel characteristics* normally meant the total fine fuel load. However, while fuel load is positively correlated with fire intensity it is very poorly correlated with fire spread rate, and the interactions between fuel characteristics and fire behaviour can be better described using a combination of fuel structure, continuity and type.

As a result, fuel hazard rating systems have been developed which describe fuel in terms of its structure, percentage of dead fuel, height and the continuity between different parts of the fuel array. These fuel hazard rating systems break the fuel array into surface, near-surface, elevated and bark stratums (Figure B1).

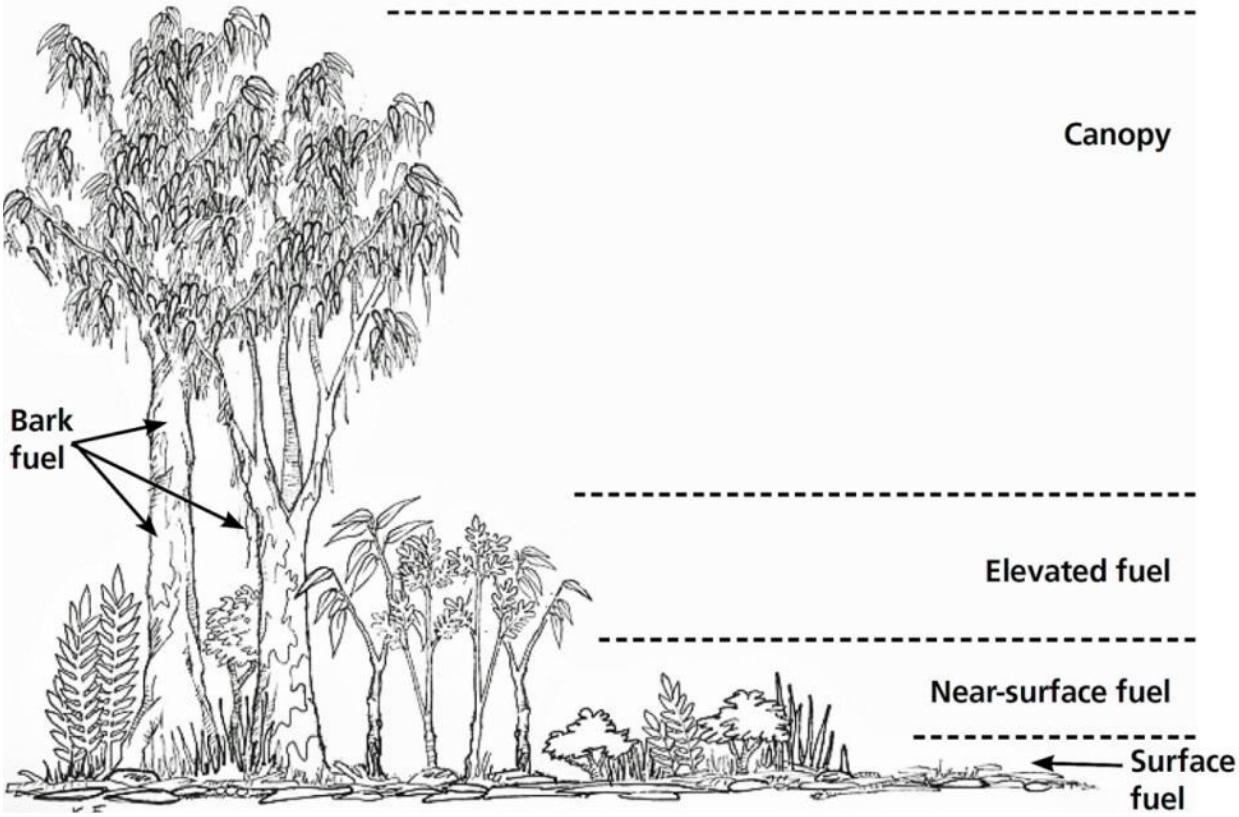


Figure B1. Fuel hazard strata. Figure copied from Hines et al. (2010).

Each fuel hazard stratum is rated on a five point scale between low, moderate, high, very high or extreme. In addition, the level of surface and near surface fuel hazard may be combined into a single rating, and all of the fuel stratums may be combined to form the overall fuel hazard rating.

Note that when fuels are assessed for fire management purposes, only fuel particles up to 6 mm in diameter (plus any bark in the fuel stratum) are included in the fuel hazard rating.

In Tasmania, the system used for assessing the level of fuel hazard rating is based on the Victorian Overall Fuel Hazard Guide (Hines et al. 2010[12]). In general, following fire the level of fuel hazard rating increases rapidly before plateauing and reaching equilibrium by about 20 to 30 years of age.

Information on the fuel hazard rating of each stratum can be obtained from field surveys and/or in the case of dry forests and buttongrass moorlands predicted from models based on the time since the last fire (see Marsden-Smedley et al. in prep 2022[13]; Marsden-Smedley et al. 1999[14]).

[12] Hines F, Tolhurst KG, Wilson AAG and McCarthy GJ 2010. Overall fuel-hazard guide. 4th edition, Report 82, Fire Management Branch, Department of Sustainability and Environment, Melbourne, Victoria.

[13] Marsden-Smedley JB, Anderson WR and Pyrke AF. In prep 2022. Fuel in Tasmanian dry eucalypt forests: prediction of fuel hazard rating and fuel load.

[14] Marsden-Smedley JB, Rudman T, Catchpole WR and Pyrke AF 1999. buttongrass moorland fire behaviour prediction and management. TasForests 11: 87-107.

3.4.3 Vegetation change mapping

Initial assessment of the available historical photographs, aerial photographs and satellite images indicated that there had been marked changes in vegetation type and coverage on the northern part of Deal Island. Further examination of the images indicated that similar changes were also occurring on Erith Island.

These changes in vegetation mainly concern expansion she-oak (*Allocasuarina verticillata*) forest and woodland into poa grassland (*Poa poiformis*).

Prior to the first available aerial photograph (ie in 1982) these changes have been described descriptively. For the 38 years between 1982 and 2020, the area of grassland has been mapped by on-screen digitising of the images in Table 1.

3.5 Fire history

Fires prior to the 1986 fire have been described descriptively with fires after this time being mapped.

The 1986 fire was mapped from the NSCA aerial photograph and the 1994 fire was mapped from a combination of the 2000 and 2007 aerial photographs (Table 1).

3.6 Fire management

The main influences on fire behaviour are wind speed, slope, fuel hazard rating, dead fuel moisture and the degree of atmospheric instability (see Box 2). The models recommended for predicting fire behaviour are summarised in Box 3. If a decision is made to perform planned burning, the recommended guidelines are in Box 4 and the typical planned burning objectives are in Box 5.

3.7 Weed mapping

The weed mapping was performed in two stages with an initial weeding in December 2021 and January 2022, then follow-up weeding in February 2022.

All of the weed data was converted into GPX format and down-loaded into GPS units for field checking.

3.8 Visitor monitoring

Observations were made as to all boats and sea kayakers observed on Deal and Erith Islands.

3.9 Bushfire risk assessment

Bushfire risk on Deal Island has been assessed using the Tasmanian emergency risk assessment guidelines (TERAG)[15], the Australian standard for building in bushfire-prone areas[16] and the fire ecology of the island's vegetation associations.

A major issue that needs to be considered is the bushfire preparedness, experience and competency of the island caretakers. In the event of a bushfire occurring, it is highly unlikely that on-site assistance will be available from PWS staff within the first four to six hours (and probably the first 24 hours). This means that the caretaker's house must be able to be used as a fire refuge in the event of a bushfire.

[15] TERAG 2017. Tasmanian emergency risk assessment guidelines. Department of Police, Fire and Emergency Management, Tasmania.

[16] AS3959-2018. Australian standard for construction of buildings in bushfire-prone areas. Standards Australia.

3.9.1 Tasmanian Emergency Risk Assessment Guidelines

The TERAG uses consequence and likelihood to assess the level of risk and provides a structured, consistent and repeatable methodology for assessing risk.

The first step in the TERAG system is to assess the current control strength (ie effectiveness) and expediency (ie how frequently controls are utilised). These are then combined to assess effectiveness of current risk management actions. The second and third stages are to determine the risk consequence and risk likelihood. The likelihood and consequence are then combined to assign a risk probability. The final stage is to determine the level of overall risk.

3.9.2 Australian standard for building in bushfire prone areas

The Australian standard for building in bushfire-prone areas provides guidance on the ability of different building construction standards to withstand bushfire impacts.

The main aim of the Australian standard for building in bushfire prone areas is to calculate the Bushfire Attack Level (BAL) rating that a building needs to be protected against. Whilst it is acknowledged that the standard is only intended to apply to new buildings, it does provide guidance as to the setbacks required in order for the island's buildings to provide refuges in the event of a bushfire.

3.10 Communication

Whilst on Deal Island, we did twice daily phone-ins to the security company Golden Electronics. In the caretaker house we used the installed phone. This was reliable but crackly and frequently hard to understand. The house also has a mobile signal booster which worked for voice calls and the internet about 1% of the time.

In addition, when walking and travelling around the island GW carried the PWS satellite phone and a PLB while JMS carried a Garmin 66i InReach. The advantage of the InReach is that it has good battery life and is a combination of high-end GPS and satellite communicator.

On Deal Island, we found that reasonable mobile reception could be obtained from the Telstra seat above East Cove, the seat on the road to the airstrip and at the junction of the Pegleg and Winter Cove tracks. There was also moderate mobile reception on top of some of Deal Island's hills and poor reception on Barn Hill. There is good mobile reception at the lighthouse.

Deal Island museum by moonlight

Box 2: Influences on fire behaviour

The main influences on fire behaviour are wind speed, slope, fuel hazard rating, dead fuel moisture and the degree of atmospheric instability.

Of these factors, wind speed is the most important, accounting for about half of the observed variation in fire spread rate (Sullivan 2009[17]). Wind acts to push flames down closer to unburnt fuel, carries embers forward to ignite unburnt fuel and increases the air supply to the fire.

Fires approximately double their spread rate for every 10° upslope and approximately half their spread rate for every 10° down slope (McArthur 1967[18]). In addition, during high intensity forest fires burning in undulating country, the effect of spotting across lee slopes onto the next uphill slope overcomes the effect of fires burning slowly down lee slopes before burning rapidly up the next upslope, meaning that the effects of slope can be ignored.

The issue of fuel hazard rating has been discussed in Box 1. The fuel inputs used when predicting fire spread rate in forests are the surface and near surface fuel hazard rating, fire age (ie the time since the last fire) is used in buttongrass moorlands, elevated fuel height, used in dry scrub and wet scrub; and the percentage of dead fuel (ie curing) is used in grasslands.

The most important factors influencing the dead fuel moisture are humidity, amount of solar radiation (which is in turn influenced by cloud cover, season, slope and aspect) and precipitation. The humidity of the atmosphere is estimated from the atmospheric water vapour pressure and is normally described using relative humidity and dew point temperature. Precipitation includes all moisture particles large enough to be deposited on the fuel (eg condensation, dew fall and rain).

By itself, temperature only has very minor influences on fuel moisture and minimal influences on fire spread rate and intensity. The air temperature does, however, strongly influence fire crew fatigue and the ability of fire crews to perform on-the-ground fire management.

When the atmosphere is unstable it is likely that large convection columns will develop, increasing the potential for low humidity along with abrupt changes in wind speed and direction. Conversely, when the atmosphere is stable fires typically burn with reduced spread rates and intensities without developing large convection columns. Due to the complexity of estimating the degree of atmospheric instability, a simple index has been developed called the Continuous Haines Index (normally referred to as the C-Haines Index, see Mills and McCaw 2010[19]). The C-Haines Index varies between a minimum of 0 (highly stable) and a maximum of about 13 (highly unstable). In Tasmania, the C-Haines Index is forecast on a routine basis throughout the fire season as part of the Fire Weather Forecast by the Bureau of Meteorology.

In general, decreased levels of fire behaviour (ie fire spread rate, intensity, spot fire number and spot fire distance) normally occur when the C-Haines is between about 0 and 4, fires burn as expected when the C-Haines Index is between about 5 and 7, moderate increases in the level of fire behaviour typically occur when the C-Haines Index is between 8 and 10 and marked increases in the level of fire behaviour typically occur the C-Haines Index is between about 10 and 13.

For example, when the atmosphere is unstable, fires burning under conditions that would normally result in low intensity, controllable fires may burn with enhanced levels of fire behaviour, be very hard to control and are highly likely to escape. This situation is particularly a problem when performing planned burning where the risk of fires escaping is greatly increased when the C-Haines exceeds 8 during the day prior to the burn, during the burn and/or on the days following the burn. In addition, when the C-Haines Index exceeds about 10 and the fire danger rating is between about 40 and 60 (ie at severe or extreme levels of fire danger), fires may burn with levels of fire behaviour similar to that which is expected when the fire danger rating is at catastrophic levels (ie the fire may be totally uncontrollable and result in enhanced threat levels to life and property, see Table B3.3 in Box 3).

[17] Sullivan AL 2009. Wildland surface fire spread modelling, 1990–2007. 2: Empirical and quasi-empirical models. International Journal of Wildland Fire 18: 369-386.

[18] McArthur AG 1967. Fire behaviour in eucalypt forests. Forestry and Timber Leaflet 107. Commonwealth of Australia, Canberra, ACT. Equations for this meter are in: Noble IR, Bary GAV and Gill AM 1980. McArthur's fire-danger meters expressed as equations. Australian Journal of Ecology 5: 201-203.

[19] Mills GA and McCaw L 2010. Atmospheric Stability Environments and Fire Weather in Australia - extending the Haines Index. CAWCR Technical Report 020. Centre for Australian Weather and Climate Research, Bureau of Meteorology and CSIRO, Melbourne, Victoria.

Box 3: Predicting fire behaviour

Fire attributes vegetation types

When performing fire management in Tasmania, the fire attributes vegetation types (Table B3.1; Pyrke and Marsden-Smedley 2005[20]) are recommended for determining the appropriate fire behaviour models to be used. Note that the TasVeg map (Kitchener and Harris 2013[21]) is not recommended for fire management purposes.

Table B3.1. Tasmanian fire attributes vegetation types and their suitability for planned burning.

Suitable for planned burning		*Unsuitable for planned burning*	
Df, Dd	dry forest and woodland	Ac, As	alpine and subalpine heathland +/- conifers and fagus
Bs	buttongrass moorland	Ag	alpine native grassland
Hh, Ds	heathland and dry scrub	Sp	sphagnum
Ws	wet scrub	Rf, Rc	rainforest +/-conifers and fagus
Gr	native grassland	Mf, Wf, Sr	mixed forest, wet forest, plantation
We	flammable weeds	Dp	damp forest
Possibly suitable for planned burning		Pt	agricultural land
Wl	swamp and wetland	Zz	urban and/or non-vegetated

Predicting fire behaviour

Wind speed, fuel hazard rating, dead fuel moisture and slope are the main inputs used when predicting fire behaviour. Wind data from the Bureau of Meteorology is predicted for a height of 10 m above the ground (ie the 10 m wind speed) while wind speeds recorded in the field are measured at about 2 m. To convert a 10 m wind into a 2 m wind, multiply by 0.66. To convert a 2 m wind into a 10 m wind, multiply by 1.5. In addition, when predicting forest fires it is also necessary to modify the 10 m wind speed for the effects of forest density and height using the unpublished wind speed correction factor contained within McArthur's (1967[22]) forest fire model:

In-forest wind speed = (1.48 - 0.237 * veg type + 0.00436 * wind speed) * wind speed

veg type: dry woodland=2, dry forest=3, damp forest=4, wet forest=5, mixed forest and rainforest=6.

A range of models are available to predict the fire danger rating, fire spread rate and intensity (Table B3.2). Two systems are used in Tasmania to predict the level of fire danger, the Forest Fire Danger Rating (McArthur 1967) and the Moorland Fire Danger Rating (Marsden-Smedley et al. 1999[23]). Both of these fire danger rating systems estimate the level of fire danger on a seven point scale between low and catastrophic (Table B3.3).

The Phoenix RapidFire model[24] is not recommended due to it having a lower utility than the other models and due it not having been independently tested and its effectiveness verified.

Table B3.2. Fire behaviour models for Tasmanian fire attributes vegetation types.

Vegetation group	Factor	Model	Reference
forest: dry, damp, wet, mixed and rainforest	fire danger spread rate, flame height	Forest Fire Danger Rating Project Vesta, Equations 10, 11	McArthur (1967) Cheney et al. (2012[25])
buttongrass moorland	fire danger spread rate, flame height	Moorland Fire Danger Rating Moorland fire behaviour model	Marsden-Smedley et al. (1999)
heath, scrub, weeds	spread rate	Heathland fire model	Anderson et al. 2015[26]
native grassland	spread rate	Grassland model	Cheney et al. 1998[27]

Table B3.3. Fire danger rating categories.

Low	0 to 5	fire control relatively easy, suitable conditions for low intensity planned burning
Moderate	6 to 11	well-resourced fire control possible, planned burning suitable if have very secure boundaries
High	12 to 24	fire control difficult and frequently fails, conditions too intense for planned burning
Very high	25 to 49	fire control very difficult, indirect firefighting only viable fire suppression methodology
Severe	50 to 74	fire control unlikely to be feasible or safe
Extreme	75 to 100	fire control not feasible or safe
Catastrophic	>100	fire control impossible, extreme threats to life and property, early relocation only safe option

[20] Pyrke A and Marsden-Smedley JB 2005. Fire-attributes categories, fire sensitivity, and flammability of Tasmanian vegetation communities. TasForests 16: 35-46.

[21] Kitchener A and Harris S 2013. From Forest to Fjaeldmark: Descriptions of Tasmania's Vegetation. Edition 2. Department of Primary Industries, Parks, Water and Environment, Tasmania.

[22] McArthur AG 1967. Fire behaviour in eucalypt forest. Leaflet 107, Forestry and Timber Bureau, Department of National Development, Commonwealth of Australia, Canberra, Australian Capital Territory.

[23] Marsden-Smedley JB, Rudman T, Catchpole WR and Pyrke A 1999. buttongrass moorland fire behaviour prediction and management. TasForests 11: 87-107.

[24] Tolhurst KG, Shields B, Chong D 2008. Phoenix: development and application of a bushfire risk management tool. Australian Journal of Emergency Management 23: 47–54.

[25] Cheney NP, Gould JS, McCaw WL and Anderson WR 2012. Predicting fire behaviour in dry eucalypt forest in southern Australia. Forest Ecology and Management 280: 120-131.

[26] Anderson WR, Cruz MG Fernandes PM, McCaw L, J Vega JA, Bradstock RA, Fogarty L, Gould J, McCarthy G, Marsden-Smedley JB, Matthews S, Mattingley G, Pearce G and van Wilgen BM. 2015. A generic, empirical-based model for predicting rate of fire spread in shrublands. International Journal of Wildland Fire 24: 443–460.

[27] Cheney NP, Gould JS, and Catchpole WR 1998. Prediction of fire spread in grasslands. International Journal of Wildland Fire 8: 1-13.

Box 4: Guidelines for planned burning

The guidelines in this plan for conducting planned burning in Tasmania have been updated from Marsden-Smedley (2009[28]). These guidelines have been revised to explicitly incorporate the level of overall fuel hazard rating. This allows the user to better target the conditions within which the planned burn is performed and to reduce the risk of non-target outcomes (eg failure of the planned burn to sustain or to burn with excessive levels of intensity and spread rate).

When planned burns are performed it is critical not to have all parameters at their minimum or maximum values. If planned burns are attempted with all parameters at or near their minimum values (ie lowest wind speed, temperature, curing, days since rain, Fire Danger Rating and C-Haines along with the highest RH and SDI) then it is probable that the planned burn will either fail to sustain or will burn with very low rates of spread and intensity and fail to adequately remove fuels and/or be effective at regenerating the vegetation. Conversely, if planned burns are performed with all of the parameters at or near their maximum values (ie highest wind speed, temperature, curing, days since rain, Fire Danger Rating and C-Haines along with the lowest RH and SDI) it is probable that the planned burn will have excessive spread rates and intensity, be very hard or impossible to control and will probably escape its boundaries.

When planned burns are performed for hazard reduction the aim will be to reduce the level of fuel hazard to low or moderate which will require burning at four to ten year intervals. When planned burns are performed for ecological management the aim will be to result in the regeneration of the target species and/or community, or reduce the cover of undesirable species such as weeds. With the exception of native grasslands, ecological management burns will normally be performed using a variable regime averaging about 10 to 30 years between fires. Native grassland ecological management burns will normally average about two to ten years between burns.

Table B3.3. Planned burning guidelines for in Tasmanian fire attributes vegetation.

Overall fuel hazard rating	Wind speed km/h	Relative humidity %	Soil Dryness Index	Temperature ℃	Grassland curing %	Days since rain	Fire Danger Rating
Dry forest and woodland							
L to M	10 to 20	40 to 60	25 to 125	10 to 25	N/A	≥2	≤10
H	5 to 15	50 to 70	25 to 100	10 to 25	N/A	≥2	≤10
VH to E	0 to 10	60 to 80	25 to 50	10 to 25	N/A	≥2	≤5
Buttongrass moorland, scrub boundaries							
L to M	5 to 20	40 to 70	≤10	10 to 25	N/A	2 to 10	≤10
H	5 to 15	50 to 80	≤10	10 to 25	N/A	2 to 10	≤10
VH to E	0 to 5	60 to 90	≤10	10 to 25	N/A	2 to 10	≤10
Buttongrass moorland, mineral earth boundaries							
L to M	5 to 10	40 to 70	≤20	10 to 25	N/A	4 to 10	≤5
H	0 to 5	50 to 80	≤20	10 to 25	N/A	4 to 10	≤5
VH to E	0 to 5	60 to 90	≤20	10 to 25	N/A	4 to 10	≤5
Heathland and dry scrub							
L to M	10 to 20	40 to 60	>5	10 to 25	N/A	≥2	≤20
H	5 to 15	50 to 70	>5	10 to 25	N/A	≥2	≤20
VH to E	0 to 10	60 to 80	>5	10 to 25	N/A	≥2	≤20
Wet scrub							
L to M	10 to 20	40 to 60	10 to 20	10 to 25	N/A	≥2	≤20
H	5 to 15	50 to 70	10 to 20	10 to 25	N/A	≥2	≤20
VH to E	0 to 10	60 to 80	10 to 20	10 to 25	N/A	≥2	≤20
Native grassland: lowland and highland							
L to M	5 to 20	40 to 60	N/A	10 to 25	90 to 100	2 to 10	≤5
H	5 to 15	50 to 70	N/A	10 to 25	70 to 100	2 to 10	≤5
VH to E	0 to 5	60 to 80	N/A	10 to 25	60 to 90	2 to 10	≤5
Woody weeds: gorse, broom, blackberry, spanish heath							
L to M	5 to 20	40 to 70	≤20	10 to 25	N/A	≥2	≤10
H	5 to 15	50 to 80	≤20	10 to 25	N/A	≥2	≤10
VH to E	0 to 5	60 to 90	≤20	10 to 25	N/A	≥2	≤10

Note: wind speed: measured at 10 m in forest and woodland, 2 m in other vegetation types; Fire Danger Rating: Forest Fire Danger Rating in dry forest and woodland, Moorland Fire Danger Rating in all other vegetation types.

[28] Marsden-Smedley JB 2009. Planned burning in Tasmania: operational guidelines and review of current knowledge. Fire Management Section, Parks and Wildlife Service, Department of Primary Industries, Parks, Water and the Environment, Hobart, Tasmania.

Box 5: Planned burning objectives

A fundamental aspect of planned burning is the identification of aims, objectives and targeted outcomes prior to ignition. These objectives can be grouped into three main areas: overall objectives, hazard reduction burning objectives and ecological management burning objectives.

Overall burn objectives
When conducting planned burning, the overall objective is to perform the planned burn safely whilst keeping the fire within the planned burn area. This is also a requirement of the Fire Service Act 1979.

Hazard reduction burning objectives
Hazard reduction burning is undertaken with the express objective of reducing the level of fire risk.

In order to be effective, burning will need to be performed with sufficient intensity to reduce the average overall fuel hazard rating to low or moderate whilst having coverage within the burning block of at least 70%. Planned burn coverages in excess of about 70% will only result in minor additional decreases in fire risk whilst increasing the planned burn's ecological and visual impacts.

Hazard reduction burning is normally performed at four to ten year intervals (or in the case of grasslands, between two and ten year intervals).

In addition, within the area hazard reduced, the frequent planned burning and the high degree of burn coverage required will often result in adverse ecological impacts. Whilst these impacts may be an acceptable outcome provided the level of fuel hazard and fire risk are effectively reduced, it is critical that the planned burn is strategically performed so that the reduction in fire risk is maximised whilst minimising the area subjected to planned burning.

In most situations, in order to be effective hazard reduction burns will need to be performed immediately adjacent (ie within 10 to 50 m) to assets (eg houses) and/or performed in such a way that the planned burn cuts across fire spread corridors so that the risk of large fires is reduced. Broad-scale hazard reduction burns remote from assets and/or fire spread corridors will only, at best, only result in minor reductions to the overall level of fire risk.

Ecological management burning objectives
The objectives of ecological management burning will be dependent on the requirements of the species and/or vegetation associations being managed.

The objectives may include regeneration of target species, habitat manipulation, development of burn mosaics and/or the removal of unwanted species (eg weeds).

In some situations in order to result in a mosaic of burnt and unburnt patches it may be necessary to conduct ecological management burning at lower intensities and coverages than is required for effective hazard reduction burning. This means that ecological management burning may be ineffective at reducing the level of fire risk. The main advantage of developing a mosaic of burnt and unburnt patches is that it has the potential to provide a range of burn ages along with shelter in unburnt patches in close proximity (ie within a few metres) to highly palatable regenerating vegetation.

Ecological management burning may be conducted to promote native herbivore numbers and/or stock by regenerating native grasses, herbs and forbs whilst reducing the coverage of less palatable species (particularly woody heath and scrub species). This is because many plants, especially grasses and forbs, have increased palatability in their first one to three years.

In Tasmania, weed management burning commonly targets gorse, broom, Spanish heath and/or blackberries. A critical factor when using fire for weed management is that it should only be conducted when adequate follow-up resources are available so that repeated treatments can be undertaken. If follow-up resources are not available, the initial treatment should not be performed. This is due to the potential of fire to regenerate and expand weed populations. The aim of burning for weed management is to remove adult plants so that access for post-burn treatments is improved, promote seedling germination so that weed seed banks are depleted and/or to reduce the amount of herbicide required during post-fire treatments (typically, the amount of herbicide required during post-fire treatments will be reduced by up to 90%). It is critical that follow-up weed treatments be conducted prior to the weeds reaching maturity and replenishing seed banks. Post-fire spraying of weed regeneration may also be used to increase the weed's proportion of dead fuel and flammability allowing for shorter periods between treatment fires.

4 Tasks performed

The time spent doing caretaker jobs is summarised in Table 3. In addition to the times spent doing caretaker jobs, considerable time was spent in the garden.

The major tasks performed during the caretaker period were:

- managing the compound, airstrip, lighthouse and walking tracks;
- visitor monitoring;
- vegetation, fuel and fire history mapping;
- weed management and mapping;
- wildlife monitoring using camera traps;
- report writing and documentation of work.

Table 3. Hours spent doing work on Deal Island.

Time period	Job	Prep	Field	Write-up, mapping	Misc	Total
Prior to Deal Is	preparation of map data	2		6		8
	downloading weed data	3				3
	downloading species distribution data	2				2
	downloading of veg map information			5		5
	preparation of camera trap data	2				2
	reading PWS material and induction	2			4	6
	subtotal: work prior to going to Deal island	11		11	4	26
December	on-island induction				3	3
	signs and visitor management	3	7			10
	monitoring rainfall and power system		7			7
	Winter Cove water station	2	3			5
	equipment maintenance		5			5
	mowing: outer compound		4			4
	mowing: airstrip		2			2
	mowing: access tracks		2			2
	camera traps		4		1	5
	vegetation and fuel mapping	2	6	10		18
	fire history mapping			4		4
	vegetation change mapping			7		7
	weed mapping		6	2		8
	report writing			22		22
	subtotal: December	7	46	45	4	102
January	monitoring rainfall and power system		7			7
	repairing compound gates		4			4
	mowing: inner compound		2			4
	mowing: outer compound		3			3
	mowing: airstrip		2			2
	mowing: access tracks		2			2
	fire hydrant assessment		2			2
	setting up camera traps and processing data		3	1		4
	vegetation distribution, fuel and change mapping		6	7		13
	weed management		14	14		28
	bushfire risk assessment			7		7
	report writing			22		22
	subtotal: January	0	45	51	0	98
February	monitoring rainfall and power system		7			7
	mowing: compound		3			3
	mowing: airstrip		2			2
	mowing: access tracks		3			3
	fire hydrant assessment		3			3
	assisting contractors		2			2
	setting up camera traps and processing data		3			3
	weed management		10			10
	bushfire risk assessment			12		12
	report writing			24		24
	total February	0	33	36	0	69
Total Deal Island						**295**

4.1 Site maintenance

4.1.1 Mowing

The main mowing jobs were the airstrip, outer compound and inner compound, along with some mowing of access tracks. The mowing of the airstrip, outer compound and inner compound respectively took about two, three and two hours, and required the use of about 15 l of petrol (mostly for the ATV). These areas were mowed three times during our caretaker period.

An unsuccessful attempt was made to brush-cut the fence line around the airstrip. The main issue was the short time between having to re-fill the bush-cutter spindle and the inability of the brush-cutter to remove tussocks. As a result, the airstrip fence line was cleared by a combination of hand pulling of bracken, chipping and mowing using the push mower.

Due to the access tracks being reasonably clear when we arrived on the island and the effects of wallaby grazing, only limited time was spent mowing access tracks.

An assessment was made as to whether it would be practical to decrease the outer compound size by moving the fencelines. Whilst this would be possible, it would only result in a minimal decrease in the time and effort spent mowing. This is because most of the area that would be removed from mowing is straight runs, with it still being necessary to mow around the buildings and other obstacles (eg houses, museum, workshop, solar panels, wind tower and rain gauge) which take most of the time and effort. In addition, there would probably only be a minor reduction in the fuel used because the remaining mowing is mostly slow, stop-start with tight turns. From the perspective of bushfire risk, it would also be advisable to keep the outer compound at its current size (see Section 4.9).

4.1.2 Rainfall and power system

The rainfall gauge and power system were checked at about 09:00 each morning. This normally took about 10 to 15 minutes per day. Visitor monitoring was done at the same time as the power and rain monitoring.

Rainfall was below average in December and February but above average in January. In December, January and February respectively we recorded 16.7 mm, 92.0 mm and 3.5 mm (average for December, January and February respectively is 50.3 mm, 48.2 mm and 38.1; Figure 28a). Note that most of the rainfall fell during a few large rainfall events, with 11.2 mm on 09 December, 16.5 mm on 07 January, 35.5 mm on 15 January and 14.6 mm on 29 January.

4.1.3 Preparation and installation of signs and visitor information

At the start of our caretaker period, covid awareness and check-in signs were set up at East Cove, compound, Garden Cove and Winter Cove. A fuel stove only sign was set up at Winter Cove and a biosecurity sign at East Cove. Signs stating that the museum and information room were closed were also set up. A white board and desk containing information sheets and an activity register was set up outside the information room (Figure 1a to 1e).

4.1.4 Winter Cove water station

A water station containing two 20 litre water cans in a small shelter was set up at the end of the Winter Cove vehicle track for kayakers use (Figure 1f). This water station was used by the first kayakers to arrive on Deal Island from mainland Tasmania.

a) Covid and biosecurity signs at East Cove

b) Museum closure sign

c) Fuel stove only sign at Winter Cove

d) Covid signs on compound gate

e) Visitor check-in station

f) Water station near Winter Cove

Figure 1. Signs and infrastructure set up at the compound, East, Garden and Winter Coves.

4.1.5 Equipment maintenance

During the course of our caretaker period, maintenance was performed on the backup diesel generator, tow-behind mower and ATV.

When undergoing routine testing, the diesel back-up generator registered that it was overheating and automatically shut-down after running for between 15 and 45 minutes. The temperature registered by the generator when it cut out was about 67℃. The thermostat was removed and tested, and whilst found to be slow in its response, was working. The generator was tested with the thermostat removed and it ran normally, although the registered water temperature was only 46℃. The

problem is probably a faulty temperature sensor. The rest of the power system worked faultlessly.

The main drive belt on the tow-behind mower was very loose and worn at the start of our caretaker period and failed after about five hours mowing. The replacement B85 belt was then fitted. The problem with the tow mower is probably that the main belt's tension spring is too weak and needs replacing.

The battery in the ATV goes flat within a few days of being charged and needs replacing. The grease nipple on the front LHS of the ATV was replaced and the suspension lubricated. The use of the blue grease gun in the workshop is not recommended due to the difficulty of removing it from grease nipples.

4.1.6 Garden and compound

Much time was spent maintaining the garden, with the reward being a steady supply of vegetables, especially snow-peas, green beans, salad leaves, kale and tomatoes (Figure 2). On average, about 30 minutes was spent per day in the garden.

The garden is highly productive and a major asset to the caretakers. The she-oak needles under the house's shelter trees were collected and used as garden path mulch (Figure 2a).

The gas gun rat traps in the garden appeared to work well, resulting in four dead brown rats.

The caretaker and visitor houses and the museum were cleaned and maintained, including additional small tasks such as polishing woodwork, silverfish control, tidying and rearranging files.

a) Gathering casuarina needles for paths

b) Garden gate

c) Garden vegies

d) Garden vegies

Figure 2. Deal Island vegetable garden.

4.1.7 Fire extinguishers, hydrants and assistance to maintenance people
Assistance was provided with the assessment and servicing of the island's fire extinguishers.

The pipes feeding the compound's hydrants were investigated at the request of the PWS rangers so that they could be upgraded to the required standard.

Assistance was also provided when the fire hydrant pipes and house stoves were replaced and the caretaker house gas heater was upgraded.

4.1.8 Track maintenance
Tracks were maintained periodically during our caretaker period. As well as mowing, fallen tree limbs and branches were removed either by hand or using the reticulated saw. Track markers were placed on the Lighthouse track to make hazards such as drainage ditches more visible when driving the ATV.

The track from the new water station down to Winter Cove is difficult to mow or brush-cut because it is steep and slippery. Some of the ferns and the great mullein that occurs there was hand pulled, and a thicket of nettles was removed from around the path crossing the creek at the bottom.

4.2 Visitor monitoring
Visitor management was an on-going job.

No boats or other visitors were encountered during the first two weeks of our period (when Tasmania was officially closed to mainland visitors due to covid).

Our first two visitors arrived by kayak from the mainland via Hogan Island on 14 December (the day Tasmania officially opened), with our second kayak group of four people arriving from Tasmania a day later. We then had a steady stream of yachts and motor boats with there being few nights when there were no boats in East Cove.

We also had one heli-evacuation to Victoria on Monday 21 February of an injured bushwalker who fell whilst on Erith Island and severely cut his head.

Victorian air ambulance performing heli-evacuation of injured bushwalker

Table 4. Visitors to Deal Island between December 2021 and February 2022.

Dates	Boat type	Stay length	Visitors	Overnight location	Visited	Notes
14-16/12/21	kayakers	2 days	2	EC, WI		heading south
16-23/12/21	kayakers	8 days	4	WI, WC	LH, SC	heading north
23-24/12/21	yacht	1 days	2?	EC		heading south
27-28/12/21	yacht	1 days	4	EC	EI	heading north
25/12/21	sharkcat	2 hours	?	WC		
26/12/21-19/01/22	catamaran	24 days	11	EI	EI, EC, LH	Erith mob #1
29/12/21	chopper	30 min	2	-	CP	unauthorised
29/12/21	yacht	2 hrs	?	-	EC	
29/12/21-01/01/22	catamaran	3 days	?	EC	EC	
29/12/21-01/01/22	yacht	3 days	?	EC	EC	
30/12/21-01/01/22	yacht	2 days	2	EC	EC	heading south
30/12/21-01/01/22	motor boat	2 days	2	WC	EC	
30/12/21-01/01/22	catamaran	2 days	?	EC	EC	
31/12/21-01/01/22	yacht	1 day	?	EC	?	
31/12/21-01/01/22	motor boat	1 day	3	EC	CP	from Flinders Island
unknown	kayakers	1 day	2	WI		from Flinders Is
03-04/01/22	yacht	1 day	?	EC	BH	
03-09/01/22	motor boat	6 days	3	EC, WC	CP, BH, LH, EI	
04-15/01/22	yacht	11 days	6	EC, WC	CP, BH, GC, WC, LH, EI	from Hobart
09-13/01/22	yacht	4 days	3	EC, GC	CP, EC, LH	heading south
09-13/01/22	yacht	4 days	2	EC	CP, BH	
11-14/01/22	yacht	2 days	3	EC, GC	EC, GC, LH	
15-17/01/22	yacht	2 days	4	EC	EI, LH	heading south
16-17/01/22	catamaran	1 day	?	EC	EC, EI	
18-20/01/22	motor boat	2 days	4	EC	WI, BH, LH, WC	heading south
19/01-09/02/22	catamaran	21 days	6	EI	EC, LH	Erith mob #2
21-25/01/22	yacht	4 days	?	EC		
21-25/01/22	yacht	4 days	6	EC	EC, CP	heading south
23-25/01/22	yacht	2 days	4	EC		heading south
23-24/01/22	fishing boat	o/n	?	EC		
24-28/01/22	motor boat	4 days	4	EC		
24-27/01/22	yacht	3 days	4	EC		returned 30/01/22
25-28/01/22	catamaran	3 days	3	EC		support vessel
25-28/01/22	row boat	3 days	12	EC	EC, BH, LH	charity rowers
28-29/01/22	motor boat	o/n	?	EC		
29/30/01/22	yacht	o/n	2	EC		heading north
30-31/01/22	yacht	o/n	4	EC		heading north
30/01-04/02/22	yacht	4 days	2	EC	EC, CP, LH	heading north
03-05/02/22	yacht	2 days	4	GC	EC, BH, CP, LH	heading south
03-05/02/22	yacht	3 days	4	EC, GC	BH, LH, CP	heading south
04-06/02/22	yacht	2 days	?	EC		heading south
04-05/02/22	catamaran	1 day	3	EC		heading north
04-06/02/22	yacht	2 days	3	EC	LH	from Flinders Is
04-05/02/22	yacht	1 day	?	EC		
05-06/02/22	yacht	2 days	?	EC		heading south
05-06/02/22	yacht	1 day	3	EC	LH	return trip from Tas
06-07/02/22	yacht	1 day	4	EC		heading north
05-08/02/22	yacht	3 days	3	EC	BH, WC, EI, LH	heading south
05-?/02/22	catamaran	?	?	GC		not seen, report only
06-08/02/22	yacht	2 days	3	EC	EC, LH	heading south
06-08/02/22	yacht	2 days	2	EC	EC, LH	heading south
08-09/02/22	catamaran	1 day	3	EC	EC, WC	
09-19/02/22	catamaran	10 days	12	EI	EI, LS	Erith mob #3
08-09/02/22	motor boat	1 day	2	EC	EC, CP	heading south
08-09/02/22	motor boat	1 day	2	EC	EC, CP	heading south
09-11/02/22	catamaran	2 days	4	EC	EC, LH, BH, CP	heading back to Vic
09-10/02/22	motor boat	1 day	?	WC		
09-11/02/22	yacht	2 days	?	WC		
10-14/02/22	kayakers	3 days	3	WC	EC, CP, LH	heading south
11-13/02/22	yacht	2 days	1	EC, WC	EC, CP	
11-12/02/22	motor boat	1 day	?	EC		heading south
11-12/02/22	yacht	1 day	2	EC	LH, CP	
14-16/02/22	catamaran	2 days	2	WC, EC, GC	WC, LH, EI	heading south

Table 4. Visitors to Deal Island between December 2021 and February 2022, continued.

Dates	Boat type	Stay length	Visitors	Overnight location	Visited	Notes
14/02/22	motor boat	6 hrs	2	-	-	
14-16/02/22	yacht	2 days	5	EC, GC	WC	heading south
14-15/02/22	yacht	1 day	4	WC	LH	
16-19/02/22	kayakers	4 days	2	WI	LH, BH, EC	heading south
17-19/02/22	catamaran	2 days	?	WC		
20/02/22	yacht	12 hrs	8	-	LH, GC, EC	returning south
20/02/22	motor boat	2 hrs	4	-	-	
20-21/02/22	kayakers	2 days	3	EI	LH, EC	heading south
20-22/02/22	motor boat	2 days	?	WC	EC, GC, WI	abalone boat?
22-25/02/22	catamaran	4 days	2	EC	LH, BH, CP	heading north
22-27/02/22	catamaran	6 days	2	EC		
22-27/02/22	bushwalkers	6 days	11	EI, EC	EI, DI, BH, LH	from Gippsland
22-25/02/22	yacht	3 days	?	EC		
23-25/02/22	yacht	3 days	?	EC		
23-25/02/22	yacht	3 days	?	EC		
24/02/22	power boat	o/n	?	EC		
25/02/22	cruise liner	8 hrs	90	-	EC, LH, SC, BH	Coral Explorer
25-28/02/22	catamaran	3 days	2	EC	GC, LH, BH	heading south
27/02/22	motor boat	o/n	?	EC		

Note: BH=Barn Hill, CP=compound, EC=East Cove, GI=Garden Cove, EI=Erith Island, LH=lighthouse, LS=Little Squally Cove, SC=Squally Cove, WC=West Cove, WI=Winter Cove, DI=Dover Island o/n=over-night.

In total, between the start of December 2021 and the end of February 2022 a total of 77 boats, three groups from the Erith mob, one bushwalking party and one visiting cruise ship were recorded. On average, boats and groups stayed three nights. During this time we counted a total of 297 visitors who went on-shore on either Deal Island and/or Erith Island. In total, the actual number of visitors is estimated to be between 350 and 375 (in about a third of cases, we had no direct contact with visitors).

About a third of boats (ie 25 boats) only moored overnight before heading on the next day. The most common overnight location was East Cove, accounting for about 75% of nights (some boats anchored in both East and West Cove). In addition, a small number of boats visited and/or moored overnight in Garden and Winter Coves.

The museum and information room were closed due to covid for the entire summer.

Yachts moored in East Cove

4.3 Access and points of interest

Access tracks, graves, cairns and other historical sites were mapped by JMS during the November 2015 and February 2016 FODI working bees with additional mapping during the current caretaker period (Figures 3 and 4; Table 5; Map 3).

Four large cairns have been mapped on Deal Island. The largest cairn is on Middle Hill and measures about three metres in height and two meters in diameter. With the exception of the Barn Hill Cairn, the other three cairns are located in forest or dense scrub and it is likely that they were in open vegetation when they were built.

Access around Deal Island is shown on Map 3 and consists of 4wd tracks, slashed walking tracks and off-track routes.

With the exception of the route up Middle Hill, the routes shown on Map 3 are from Bob Tyson. Bob's routes did not always follow the shortest line and several times we found out why: Bob's routes minimise scrub. The route up Middle Hill is easy as far as Winter Creek, after which it goes through very thick scrub and forest.

Table 5. Deal Island points of interest.

Item	Location	Easting	Northing	Notes
Cairn	Flag Hill	527008	5631147	
Cairn	Garden Cove	527504	5632388	
Cairn	Middle Hill	529235	5629667	2 m tall, 2 m wide with flat top
Cairn	Barn Hill	526475	5629915	2 m tall
Memorial	Garden Cove	528043	5632307	Murrerninghe shot by Bob Gambell, April 1831
Grave	Garden Cove	527972	5632316	J Stewart, 30 Sept 1849
Grave	Little Squally Cove	526992	5630230	Fanny Baker 1849
Grave	East Cove	526793	5630354	JT Hague 1924
Grave	Lighthouse	527669	5628358	Baby girl of R and M Jackson between 1877 and 1890
Memorial	Lighthouse Hill	528006	5628132	Original air crash grave site
House ruins	lighthouse	527680	5628350	
Halfway house	lighthouse road	527703	5629174	Very little left at site
Whim	East Cove	526776	5630444	
Whim	Lighthouse	527700	5628490	
Karitane	Squally Cove	528370	5628710	wrecked 1922

Carved names adjacent to the Karitane wreck in Squally Cove.

a) Murrerninghe memorial, April 1831

b) J Stewart, 30 Sept 1849

c) Fanny Baker, ~10 Oct 1849

d) JT Hague, 23 Sept 1924

e) Grave at lighthouse, between 1877 and 1890

f) Air crash site, 23 September 1943

Figure 3. Deal Island memorials and graves.

Part of the bow section of the Karitane, wrecked Squally Cove 1922

a) Flag Hill cairn

b) Garden Cove cairn

c) Barn Hill cairn

d) Middle Hill cairn

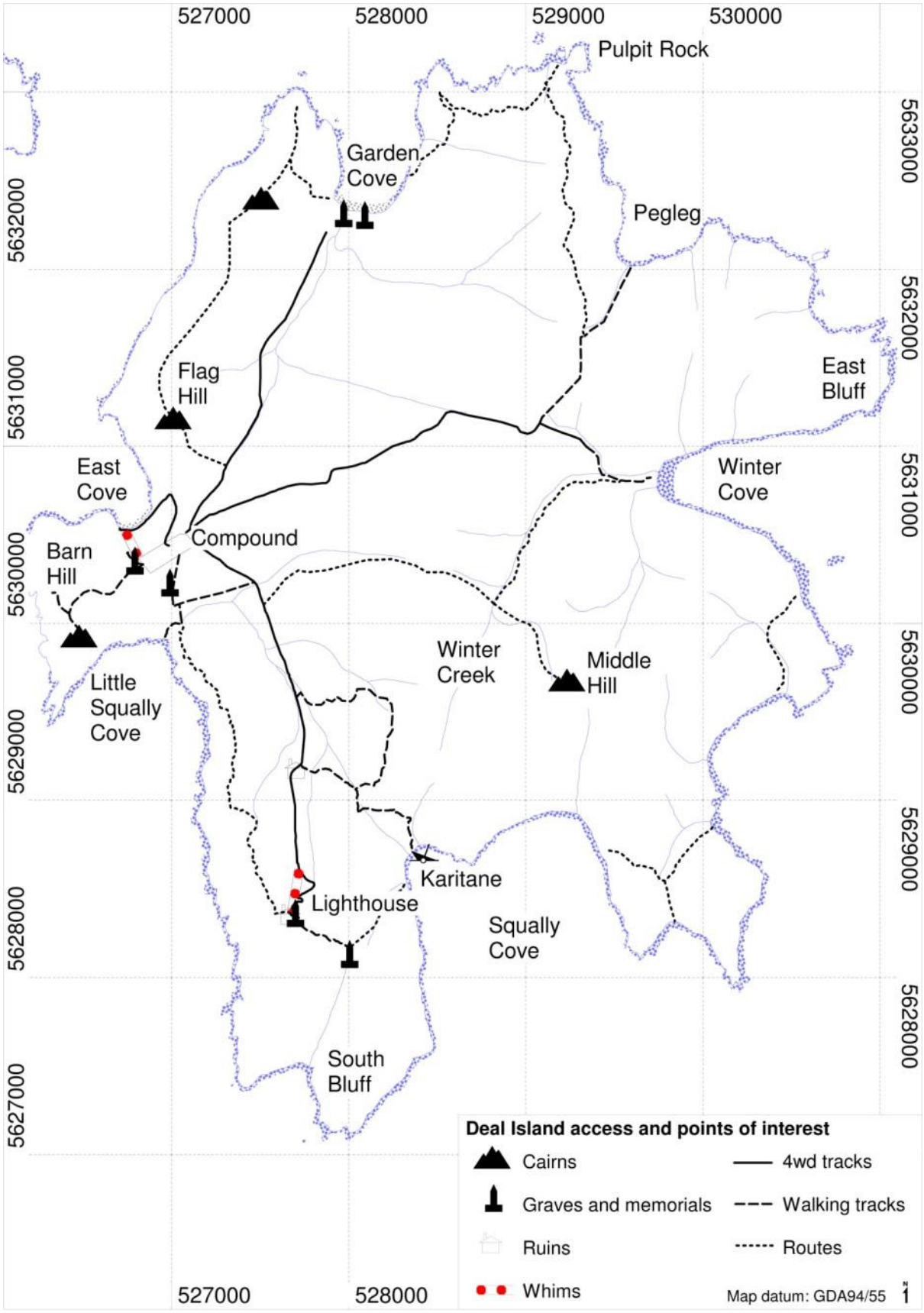
e) Lighthouse whim, top station

f) East Cove whim, top station

e) Lighthouse ruins

f) RAAF aircraft crash, 1943

Figure 4. Deal Island cairns, whims, lighthouse ruins and aircraft crash.



Map 3. Deal Island access and points of interest.

4.4 Vegetation mapping

4.4.1 Previous vegetation mapping

The vegetation maps produced by Harris and Davis (1995) and Kirkpatrick (1995) were digitised so they could be used to guide the current vegetation mapping. These maps were also compared to the current distribution of different vegetation types. However, when the Harris and Davis' (1995) vegetation map of Deal Island was examined it was found that a large proportion of the area mapped as eucalypt dry scrub was relatively young regrowth eucalypt dry forest which had been burnt about a decade previously (ie in 1972).

As a result, it is not possible to directly compare the area of different vegetation associations mapped in 1995 with the areas mapped by this project.

The digitised 1995 vegetation included 11 vegetation associations, with the area of different vegetation associations being shown in Table 6 and Map 4.

Table 6. Area covered by different vegetation types on Deal, Dover and Erith Islands in 1995.

	Deal Island		Dover Island		Erith Island	
Vegetation type	Ha	%	Ha	%	Ha	%
Dry forest and woodland						
She-oak closed dry forest	39.9	2.5	29.4	10.0	2.7	0.8
She-oak open dry forest	118.2	7.5	14.7	5.0	17.9	5.6
Eucalypt open dry forest	700.1	44.4	-	-	-	-
She-oak dry woodland	302.4	19.2	-	-	38.3	11.9
Dry scrub						
Tea-tree and kunzea dry scrub	-	-	190.2	64.5	69.7	21.6
Myoporum dry scrub	3.2	0.2	-	-	29.9	9.2
Grassland						
Poa grassland	311.5	19.8	1.8	0.6	89.6	27.7
Wet scrub						
Melaleuca wet scrub	7.6	0.5	-	-	-	-
Wetland						
Juncus	-	-	-	-	0.2	0.1
Low vegetation cover						
Bare ground: rock	90.5	5.7	59.0	20.0	74.8	23.1
Bare ground: sand	3.2	0.2	-	-	-	-

4.4.2 Current vegetation mapping

The revised vegetation map was mapped using on-screen digitising from the 2020 ListMap ESRI satellite image in association with the 2012 ListMap aerial photographs (Table 1) and ground surveys.

A total of 15 different vegetation associations have been mapped on Deal, Dover and Erith Islands (Table 7; Map 5).

The issue of changes in the area of different vegetation types since 1995 will be discussed further in Section 4.6.

Sunset from the lighthouse

Table 7. Area covered by different vegetation types on Deal, Dover and Erith Islands in 2020.

Vegetation type		Deal Island Ha	Deal Island %	Dover Island Ha	Dover Island %	Erith Island Ha	Erith Island %
Dry forest and woodland	She-oak closed dry forest	616.1	39.1	44.7	15.1	7.9	2.4
	She-oak open dry forest	135.5	8.6	62.2	21.1	88.5	26.8
	She-oak dry woodland	59.9	3.8	-	-	-	-
	Eucalypt dry forest	33.7	2.1	-	-	-	-
	Eucalypt open dry forest	244.7	15.5	11.8	4.0	-	-
Dry scrub	She-oak, tea-tree, kunzea dry scrub	21.9	1.4	109.2	37.0	-	-
	Eucalypt dry scrub	167.0	10.6	-	-	-	-
	Tea-tree, monotoca, myoporum low dry scrub	-	-	-	-	116.9	35.4
	Tea-tree, monotoca tall dry scrub	-	-	-	-	6.4	1.9
Grassland	*Poa* grassland	139.1	8.8	4.8	1.6	29.9	9.1
Wet scrub	Melaleuca wet scrub	6.0	0.4	-	-	-	-
Wetland	Juncus	-	-	-	-	0.3	0.1
Low vegetation cover	Bare ground: low she-oak cover	46.3	2.9	13.2	4.5	36.2	11.0
	Bare ground: low grass cover	5.4	0.3	-	-	-	-
	Bare ground: rock	94.5	6.0	49.3	16.7	42.8	13.0
	Bare ground: sand	2.0	0.1	-	-	1.1	0.3
	Modified: airstrip, compound	4.6	0.3	-	-	-	-

4.4.3 Vegetation types mapped

The average covers and heights of the main vegetation types are in Table 8. Photographs of the main vegetation types are in Figures 5 to 16.

Table 8. Average covers and heights of the main vegetation types.

Vegetation type		Canopy cover %	Canopy height m	Mid-stratum cover %	Mid-stratum height m	Surface type
Dry forest and woodland	She-oak closed dry forest	55	8.5	30	3.0	litter
	She-oak open dry forest	35	7.0	20	1.5	litter
	She-oak dry woodland	20	5.0	20	2.5	grass
	Eucalypt dry forest	45	17.0	30	4.5	litter
	Eucalypt open dry forest	35	6.5	30	3.0	litter
Dry scrub	She-oak, tea-tree, kunzea dry scrub	20	3.5	45	2.0	rock, litter
	Eucalypt dry scrub	25	3.5	50	2.0	rock, litter
Grassland	*Poa* grassland	80	1.0	40	1.0	grass
Wet scrub	Melaleuca wet scrub	65	6.5	70	3.0	dirt, litter

Dry forest and woodland

With the exception of areas with extreme levels of climatic exposure, cliff lines and areas with skeletal soils, she-oak (*Allocasuarina verticillata*) dry forest would be the climax vegetation type in the Kent Group of islands.

In most sites, she-oak closed dry forest takes about 20 years post-fire to form. She-oak closed dry forest forms very low species diversity stands with a dense canopy and open understories (other than for fallen trees and branches; Figure 5). Younger (ie more recently burnt) she-oak stands tend to comprise open dry forest or woodland. This transition is particularly common in areas where she-oak is expanding out into grassland. In these areas, the core, long established areas are covered by closed forest with a ring of younger open dry forest (Figure 6) around the periphery and dry woodland with a grassy understorey scattered through the grassland areas (Figure 7).

Eucalypt (*Eucalyptus nitida*) dry forest forms extensive stands, particularly on Deal Island. No other eucalypt species were recorded on Deal Island. In areas with deeper soils and/or higher moisture availability large well-developed eucalypt forest occurs, often with fairly open understories (Figure 8). In areas with shallow soils, high rock covers and/or low moisture availability the eucalypt forest is much lower, often with a dense understorey and mallee form trees (Figure 9). Interestingly, eucalypts are absent from Erith Island despite its history of frequent fire.

Dry scrub
On Deal and Dover Islands, extensive areas are covered by a diverse dry scrub association dominated by she-oak, eucalypt, tea-tree (coast tea-tree: *Leptospermum laevigatum* and manuka: *Leptospermum scoparium*) and kunzea (*Kunzea ambigua*). This association forms a continuum between she-oak, tea-tree and eucalypt dominated (Figures 10 and 11).

On Erith Island, extensive areas are covered by a diverse dry scrub community dominated by tea-tree (mostly coast tea-tree, but also manuka), monotoca (*Monotoca glauca*) and myroporum (*Myroporum insulare*; Figure 12). Over about the past 38 years the area of grassland has been greatly reduced due to invasion by this dry scrub community.

Also on Erith Island, there is a patch of tall dry scrub dominated by old-growth coast tea-tree and monotoca behind the beach (Figure 13). In the long term absence of fire on Erith Island, it is probable that the majority of the island will be covered by tall dry scrub and possibly in the very long term absence of fire, she-oak closed dry forest.

Grassland
On Deal Island, the majority of grassland is dominated by *Poa poiformis*, with about one to five percent of the area being dominated by sedges (*Lepidiosperma* spp.) and with smaller areas dominated by bracken (*Pteridium esculentum*; Figure 14). The grasslands on Erith Island have a high cover of introduced pasture grass.

This association is currently being rapidly invaded by she-oaks on Deal Island, and by dry scrub on Erith Island (see Section 4.6).

Wet scrub
Paperbark (*Melaleuca ericifolia*) wet scrub was mapped in two locations on Deal Island, both of which were in drainage lines (Figure 15).

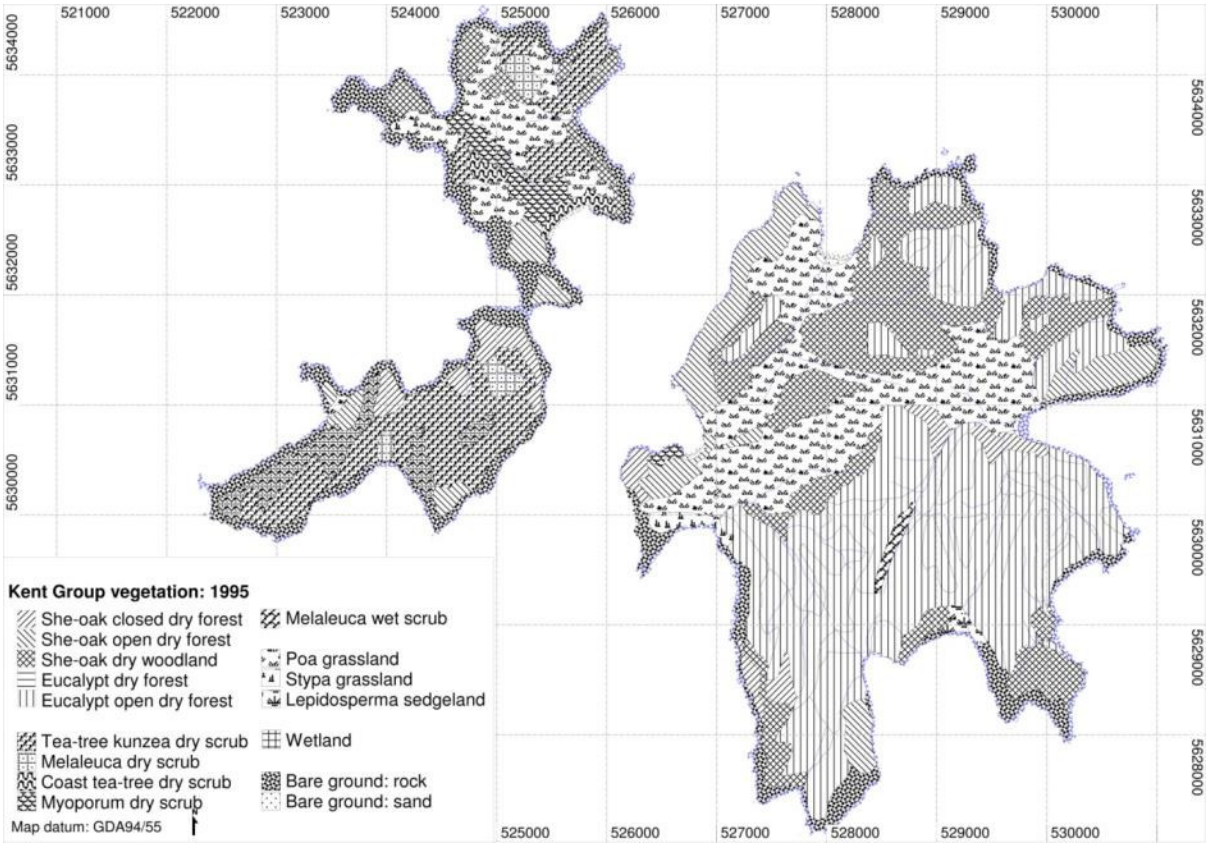
Areas with low vegetation cover
In cliff line and extreme exposure areas, vegetation with reduced covers was mapped, with these areas ranging from she-oak dominated, grass dominated, bare rock to sand (Figure 16).

4.4.4 Fuel hazard and load mapping

The average fuel strata characteristics for surface, near-surface, elevated, bark and overall fuel hazard rating (FHR) are in Table 9 and Maps 6 to 10.

The area of sites with different levels of FHR are in Table 10.

The raw vegetation and fuel strata data are in Appendix 2.



Map 4. Vegetation of Deal, Dover and Erith Islands in 1995. Data source: Harris and Davis 1995; Kirkpatrick 1995.

a) Last burnt 1994

b) Last burnt 1986

Figure 5. She-oak closed forest.

a) Last burnt 1994

b) Last burnt 1986

Figure 6. She-oak open dry forest.

a) Last burnt 1994

a) Last burnt 1986

Figure 7. She-oak woodland.

a) Last burnt 1972

b) Long unburnt

Figure 8. Eucalypt dry forest.

a) Last burnt 1994

b) Last burnt 1986

Figure 9. Eucalypt open dry forest.

a) She-oak dry scrub

b) Tea-tree and kunzea dry scrub

Figure 10. She-oak, tea-tree and kunzea dry scrub.

a) Short eucalypt dry scrub

b) Tall eucalypt dry scrub

Figure 11. Eucalypt dry scrub.

a) Tea-tree, monotoca and myroporum open dry scrub

b) Tea-tree and monotoca dry scrub

Figure 12. Tea-tree, monotoca and myroporum dry scrub.

a) Tea-tree tall scrub

b) Tall tea-tree and monotoca dry scrub

Figure 13. Tea-tree and monotoca tall dry scrub.

a) *Poa* grassland

b) Sedgy grassland

Figure 14. Open grassland.

a) Short wet scrub

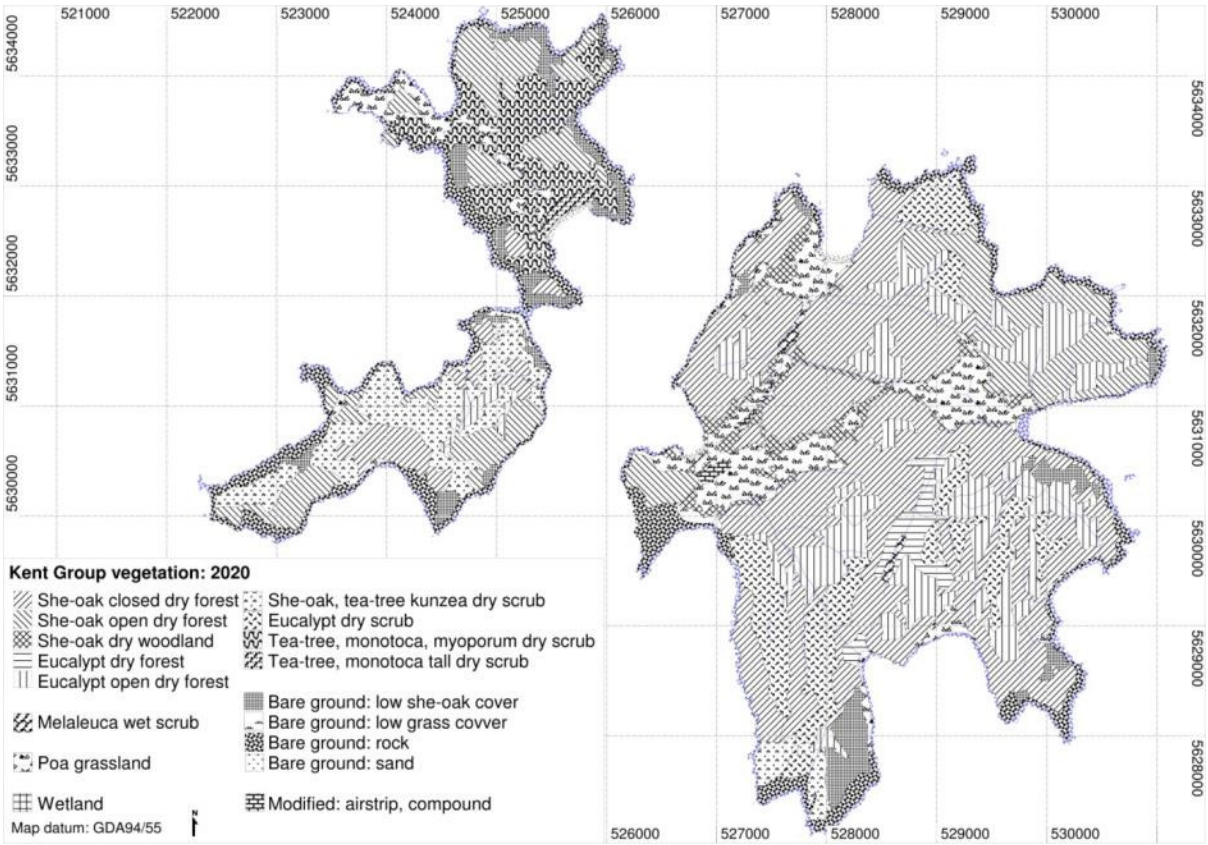
b) Tall wet scrub

Figure 15. Wet scrub.

a) Low she-oak cover over rock on cliff lines

b) Low grass cover on cliff lines

Figure 16. Bare ground with low vegetation cover.



Map 5. Current vegetation of Deal, Dover and Erith Islands. Data source: 2020 satellite image and ground surveys.

Table 9. Average fuel strata characteristics.

	Surface			Near-surface					Elevated					Bark	Overall	Fuel
Vegetation type	cvr %	hgt cm	FHR	cvr %	hgt cm	dead %	cont.	FHR	cvr %	hgt cm	dead %	cont.	FHR	FHR	FHR	load t/ha
Dry forest and woodland																
She-oak closed Df	81	3.7	H	29	36	96	H	VH	9.6	229	49	L	L	L	H	10
She-oak open Df	55	3.5	H	53	48	45	H	VH	20	300	10	L	L	L	M	11
She-oak dry Dd	50	4.5	H	66	51	53	VH	VH	10	263	16	M	M	L	H	15
Eucalypt Df 92	7.0	E	40	54	64	VH	E	24	275	18	H	VH	H	VH	20	
Eucalypt open Df	81	4.0	VH	34	49	61	M	VH	23	200	37	M	H	H	VH	10
Dry scrub																
She-oak, tea-tree Ds	50	2.5	H	45	60	50	M	H	50	213	23	H	VH	L	VH	7
Eucalypt Ds 48	4.5	H	53	83	36	VH	VH	25	238	18	H	H	L	VH	12	
Tea-tree, monotoca, Ds	30	5.0	M	75	25	50	VH	VH	30	175	30	M	H	-	VH	12
Tea-tree, monotoca tall Ds	20	1	L	30	35	40	M	M	70	250	20	VH	E	L	E	15
Grassland																
Poa grassland	46	5.8	VH	85	78	48	VH	E	<1	300	15	-	-	-	E	18
Wet scrub																
Melaleuca Ws	62	4.7	VH	33	38	97	M	H	50	300	23	E	E	H	E	15

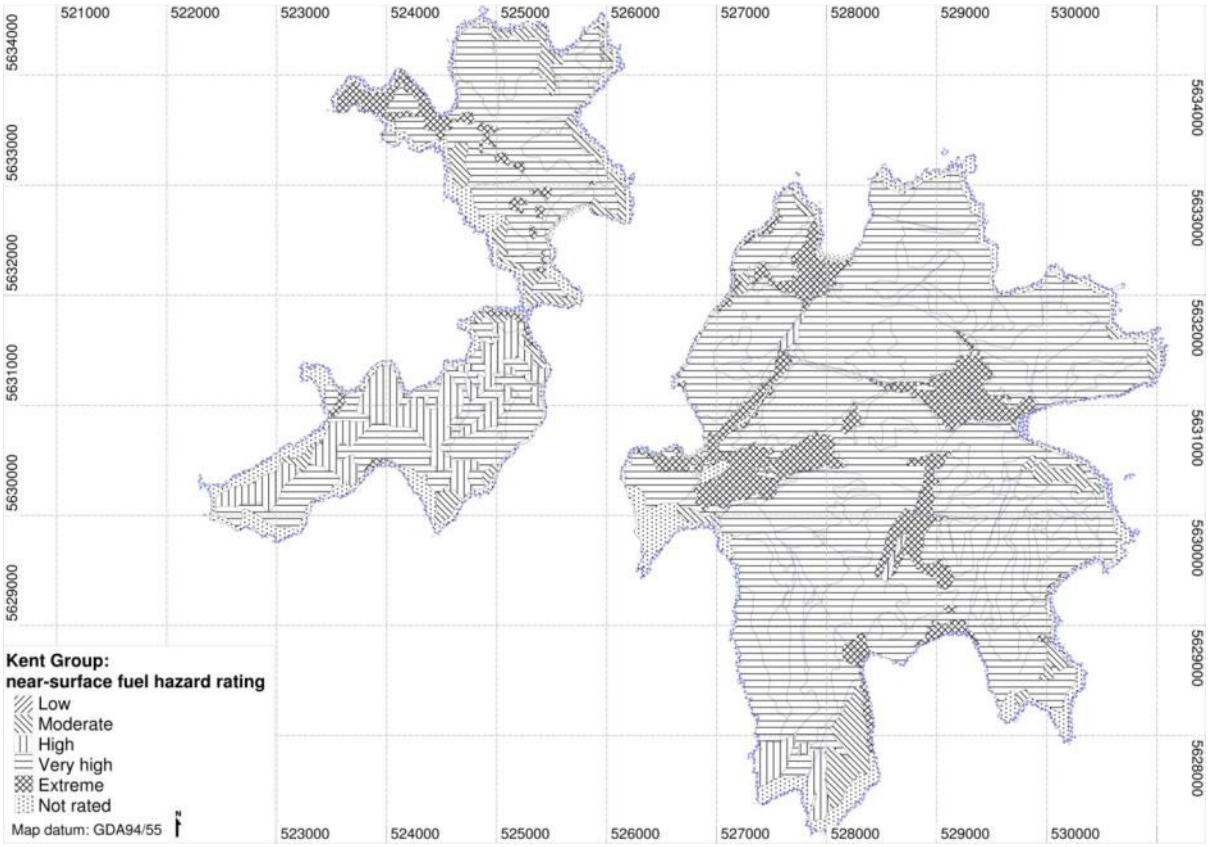
Table 10. Area of sites with different levels of fuel hazard rating.

		S FHR		NS FHR		E FHR		B FHR		O FHR	
	FHR level	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%
Deal Island	Low	0.0	0.0	0.0	0.0	797.8	50.6	1046.6	66.4	0.0	0.0
	Mod	51.7	3.3	51.7	3.3	59.9	3.8	0.0	0.0	187.2	11.9
	High	1000.3	63.4	27.9	1.8	411.6	26.1	284.4	18.0	676.0	42.9
	Very high	389.8	24.7	1223.1	77.6	55.6	3.5	0.0	0.0	467.2	29.6
	Extreme	33.7	2.1	172.8	11.0	6.0	0.4	0.0	0.0	145.2	9.2
	Not rated	101.1	6.4	101.1	6.4	245.6	15.6	245.6	15.6	101.1	6.4
Dover Island	Low	0.0	0.0	0.0	0.0	120.1	40.7	229.2	77.7	0.0	0.0
	Mod	13.2	4.5	13.2	4.5	0.0	0.0	0.0	0.0	75.4	25.6
	High	216.1	73.2	109.2	37.0	11.8	4.0	11.8	4.0	44.7	15.1
	Very high	16.5	5.6	118.7	40.2	109.2	37.0	0.0	0.0	121.0	41.0
	Extreme	0.0	0.0	4.8	1.6	0.0	0.0	0.0	0.0	4.8	1.6
	Not rated	49.3	16.7	49.3	16.7	54.1	18.3	54.1	18.3	49.3	16.7
Erith Island	Low	0.0	0.0	0.0	0.0	126.2	39.0	249.4	77.1	0.0	0.0
	Mod	159.5	49.3	36.2	11.2	0.0	0.0	0.0	0.0	118.3	36.6
	High	90.0	27.8	0.0	0.0	116.9	36.1	0.0	0.0	7.9	2.4
	Very high	29.9	9.2	213.2	65.9	0.0	0.0	0.0	0.0	137.7	42.6
	Extreme	0.0	0.0	29.9	9.2	6.4	2.0	0.0	0.0	15.4	4.8
	Not rated	44.1	13.6	44.1	13.6	74.0	22.9	74.0	22.9	44.1	13.6

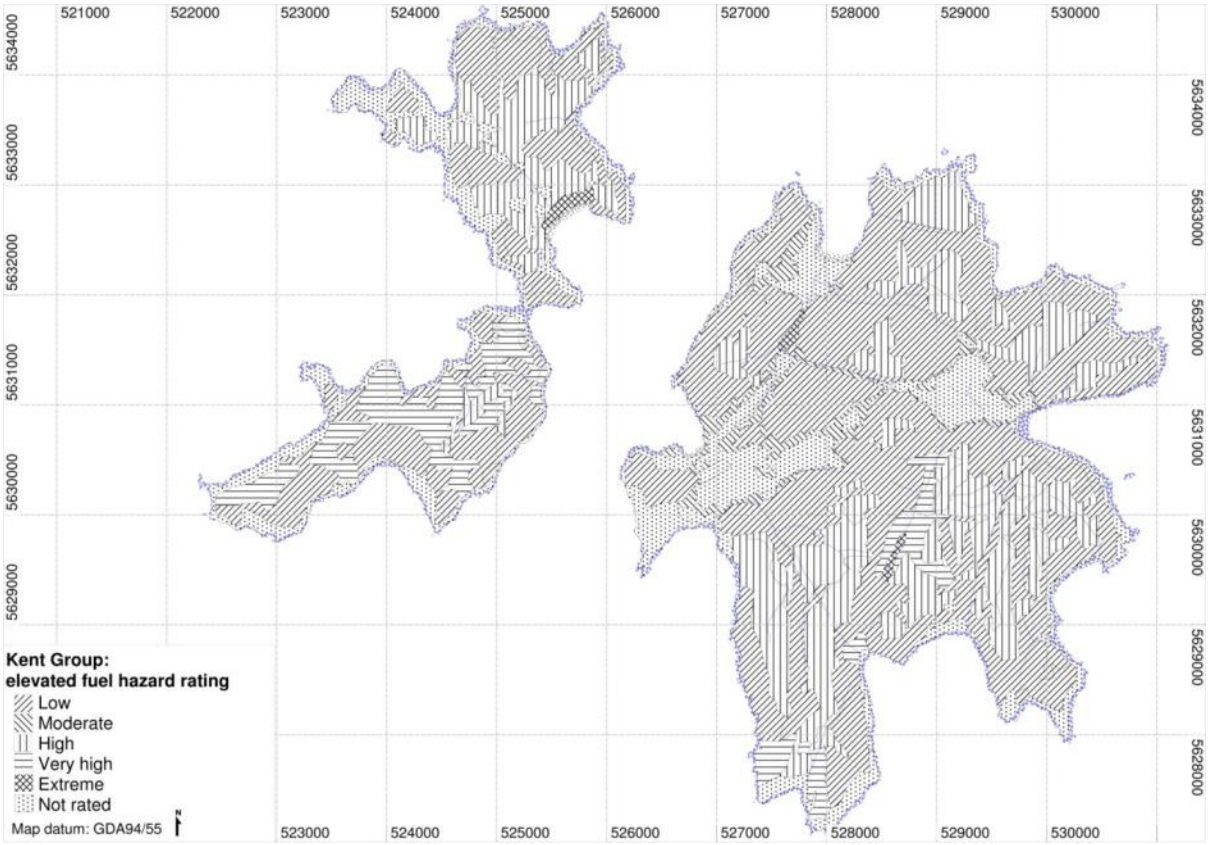
Note: S FHR = surface fuel hazard rating; NS FHR = near-surface fuel hazard rating; E FHR = elevated fuel hazard rating; B FHR = bark fuel hazard rating; O FHR = overall fuel hazard rating.

Deal Island lighthouse

Map 6. Surface fuel hazard rating.

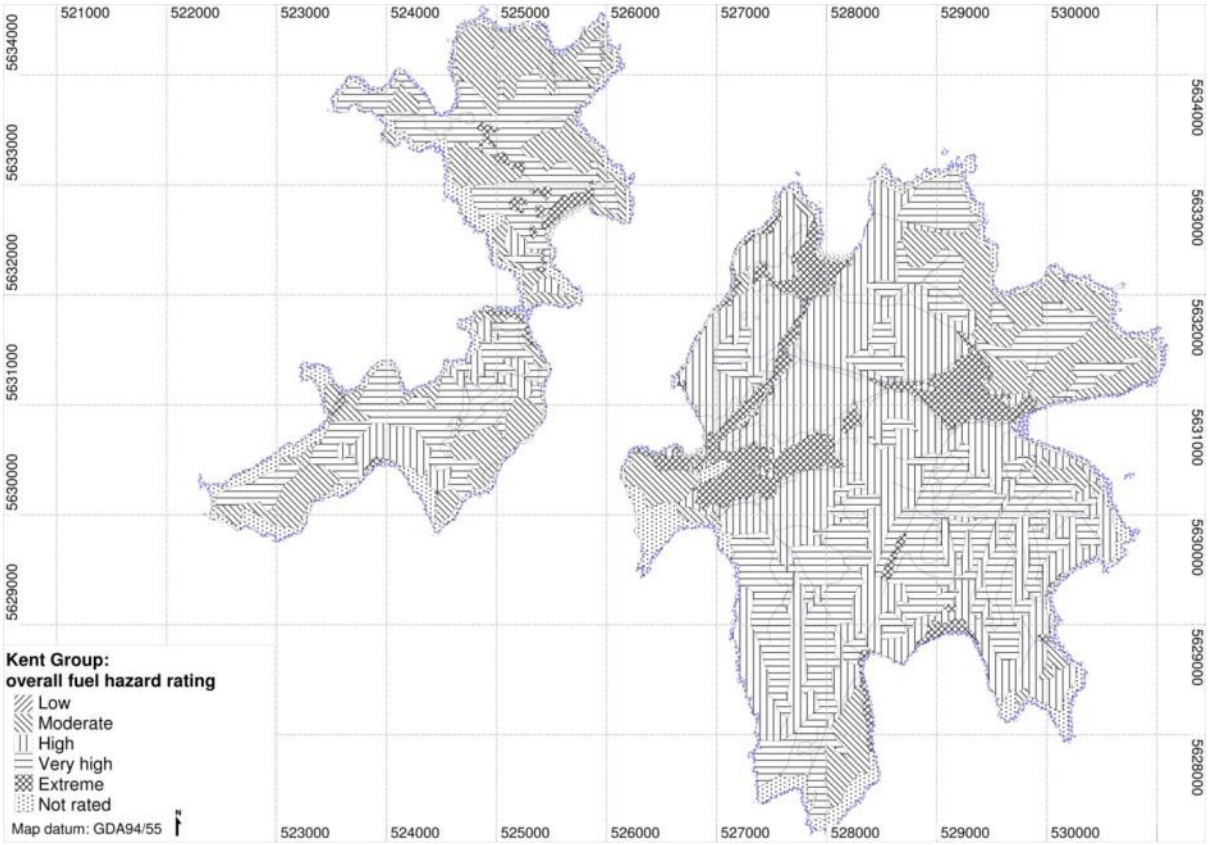


Map 7. Near-surface fuel hazard rating.



Map 8. Elevated fuel hazard rating.

Map 9. Bark fuel hazard rating.



Map 10. Overall fuel hazard rating.

Looking down onto the Dragons tail on Deal Island

4.5 Fire history of Deal Island

Deal Island has had a long history of bushfires.

However, the fire history of Deal Island is far from complete. This means that prior to the 1970s, information is only available for major fires which impacted the lighthouse and/or compound, with it being highly probable there were other bushfires.

A major bushfire occurred in 1919 which burnt the Halfway house along with the quarters at the lighthouse. It appears the buildings were then repaired with a new Halfway house being built in the 1930s[29].

A major fire was started by lightning in early November 1951 and appears to have burnt the majority of Deal Island over the following month. This fire left the Halfway house unburnt but destroyed the houses at the lighthouse[30].

There are reports of three bushfires in the 1960s but the size and areas burnt by these fires are unknown[31].

A major fire occurred in December 1972. This fire burnt all of Deal Island except for about 50 ha in cliff line areas[32]. This means the 1972 fire had an area of over 1500 ha and burnt >95% of the island. The 1972 fire burnt much of the compound area along with the generator shed at the lighthouse. The effects of the 1972 fire can clearly be seen in a panorama taken from the lighthouse in 1976 (Figure 17). The 1972 fire was first observed about half way up the cliff line about 750 m north of Little Squally Cove[33] suggesting that lightning is a plausible cause.

Fires are reported to have occurred in the grassland to the west of the compound in 1974 and 1982[34]. The 1974 fire burnt an area of about a hectare and started from the disposal of hot ashes at the tip. The 1982 fire burnt an area of about 200 ha and started from a poorly maintained vehicle.

In November 1986 the majority of the northern end of the island was burnt in an escaped “survival training” fire lit by personnel from the NSCA[35]. The 1986 fire has been mapped from an aerial photograph taken by the NSCA with the fire burning about 898 ha (about 57% of Deal Island; Map 11).

In October 1994 a fire started from the island tip when the island’s lease holder lit and poorly managed a rubbish disposal fire[36]. The fire burnt about 187 ha (about 12% of Deal Island) and caused extensive damage to the lighthouse and burnt out the lighthouse fuel store (Figure 18; Map 11).

Part of the 1994 fire re-burnt about 67 ha (4% of Deal Island) of the area that was burnt in the 1986 fire.

[29] Page 38 in: Reynolds D. Deal Island: a historical overview. Undated report in Caretakers house.

[30] Page 57 in: Reynolds D. Deal Island: a historical overview. Undated report in Caretakers house.

[31] J Whinray letter to the National Parks and Wildlife Service, November 1993. NRE Deal Island fire file.

[32] Australian Marine and Safety Authority records in Deal Island caretakers house.

[33] Australian Marine and Safety Authority records in Deal Island caretaker’s house.

[34] Report by W Hollier. NRE Deal Island fire file.

[35] NRE Deal Island fire file.

[36] NRE Deal Island fire file.

Figure 17. Panorama taken from the lighthouse in 1976 showing areas burnt by the 1972 fire.
Source: photograph in the Deal Island museum.

This means that, at the current time, about 12% of Deal Island was last burnt about 28 years ago, about 53% was last burnt about 36 years ago, with the majority of the rest of the island being last burnt about 50 years ago.

Prior to being managed for conservation in the 1990s, Erith Island was partly cleared and frequently burnt to promote fodder for cattle grazing (Kirkpatrick 1995).

Dover Island has no history of being cleared or grazed although it was periodically burnt (Kirkpatrick 1995).

It has not been possible to map the fire history on Dover and Erith Islands and there have been no recorded bushfires on these islands since the mid-1990s.

Caretaker house artwork

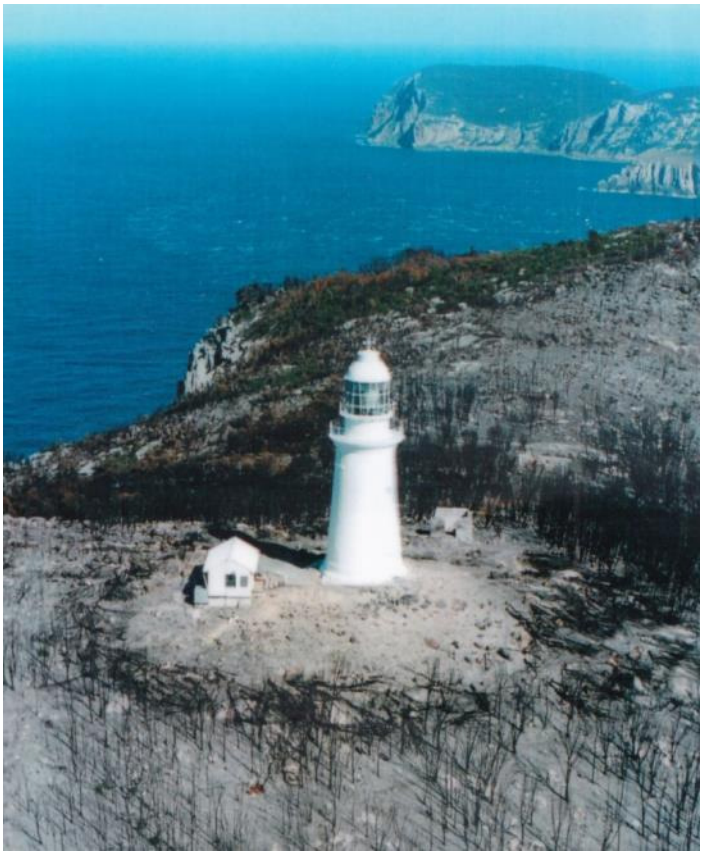
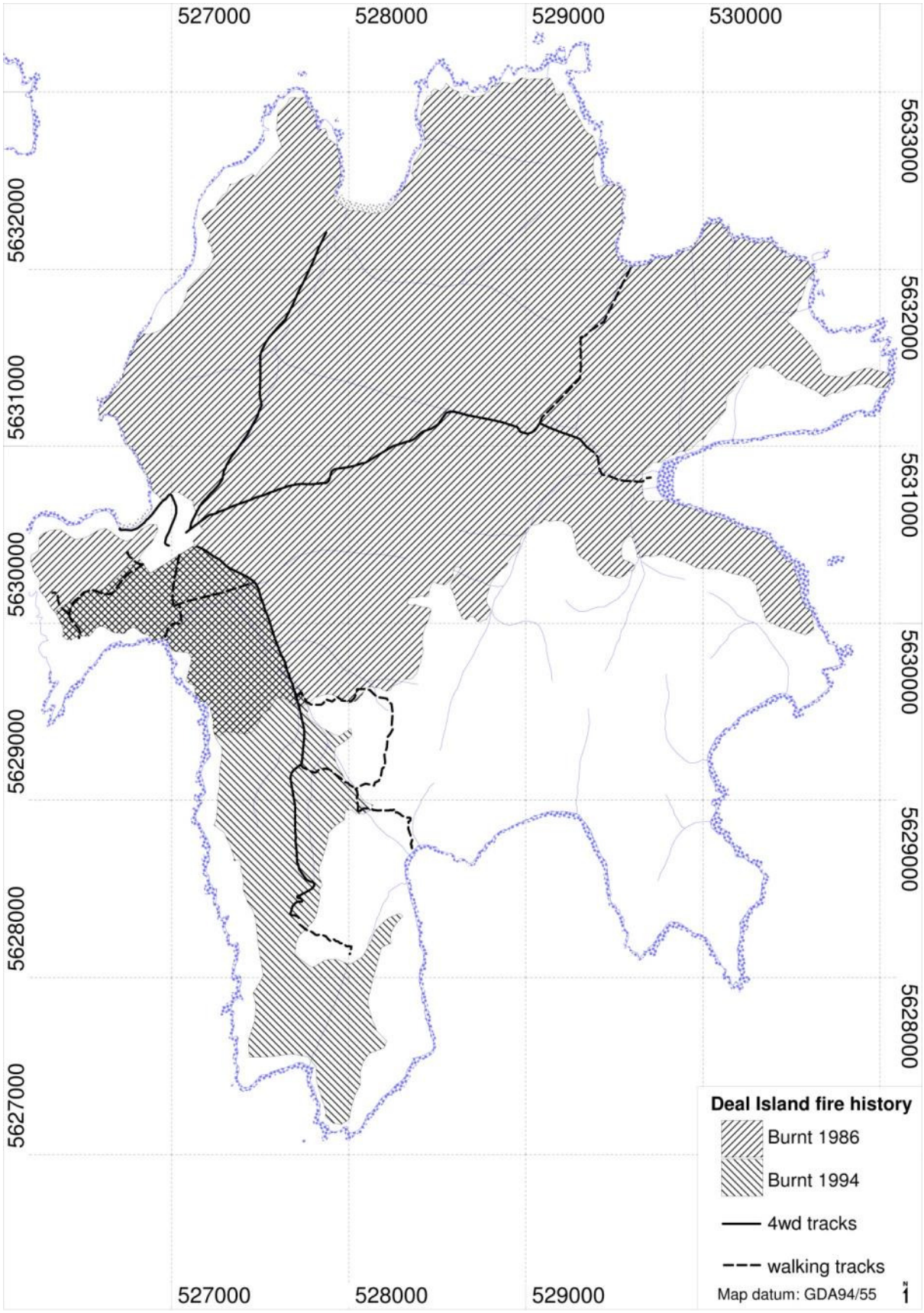


Figure 18. Photographs showing the lighthouse area burnt by the 1994 fire.
Source: Australian Marine and Safety Authority photographs.



Map 11. Deal Island fire history.

4.6 Vegetation change mapping

The Kent Group of islands have had a history of fires associated with the lighthouse keepers, stock grazing and other occupants (Section 4.5). These fires have resulted in a marked increase in the area of open vegetation on the islands, with most of this open vegetation being open grassland.

The normal fire regime in she-oak forest and woodland is one of few fires followed by a high-intensity stand-replacing fire. It is also important to note that, pre-European settlement fires would have been much less common which would have probably resulted in the majority of Deal and Erith Islands being covered by she-oak forest with smaller areas of eucalypt forest and scrub, and with dry scrub and grassland being restricted to exposed areas and/or rookeries.

An assessment of vegetation change on the islands has been made for two time periods: pre- versus post-1982 (note that the first available aerial photographs date from 1982; Table 1).

4.6.1 Vegetation change prior to 1982

The impacts from past fires can clearly be seen in historical photographs.

In these historical photographs, it appears that the majority of the northern end of Deal Island was covered by open grassland with only limited areas covered by she-oak forest and woodland.

For example, the Field Naturalist Club of Victoria[37] did a field trip to the Kent Group in November 1890. There are several photographs taken during this trip in the Deal Island museum which show extensive areas of grassland (Figure 19).

Prior to the early 1990s Erith Island was leased for the purposes of cattle grazing with the island being partly cleared using fire (Kirkpatrick 1995).

Whilst Dover Island was probably periodically burnt, no attempt was made to use it for stock grazing resulting in it continuing to be covered by native vegetation (Kirkpatrick 1995).

Pigface at Little Squally Cove

[37] Le Souff D 1891. Expedition of Field Naturalists' Club to Kent Group, Bass Straits. The Victorian Naturalist volume 7: 121-139.

a) Campsite behind Garden Cove in 1890

b) Similar view in December 2021

Figure 19. Photograph taken in 1890 compared to the current view showing vegetation change.

4.6.2 Vegetation change since 1982 on Deal, Erith and Dover Islands

On Deal and Erith Islands the area of open grassland has been mapped using the aerial photographs and satellite images taken between 1982 and 2020 (Table 1).

Note that the majority of the grasslands on the northern end of Deal Island were burnt in the 1986 NSCA fire (Map 11). The area of grassland on the vegetation maps in Harris and Davis (1995) and Kirkpatrick (1995) has also been assessed.

Over this nearly 40 year time period, the area of grassland on Deal Island has reduced in area from about 340 ha to 120 ha, a reduction in area of about 65%. On Erith Island, the area of grassland has reduced from about 132 ha to about 30 ha, a reduction of about 77% (Figure 20; Table 11).

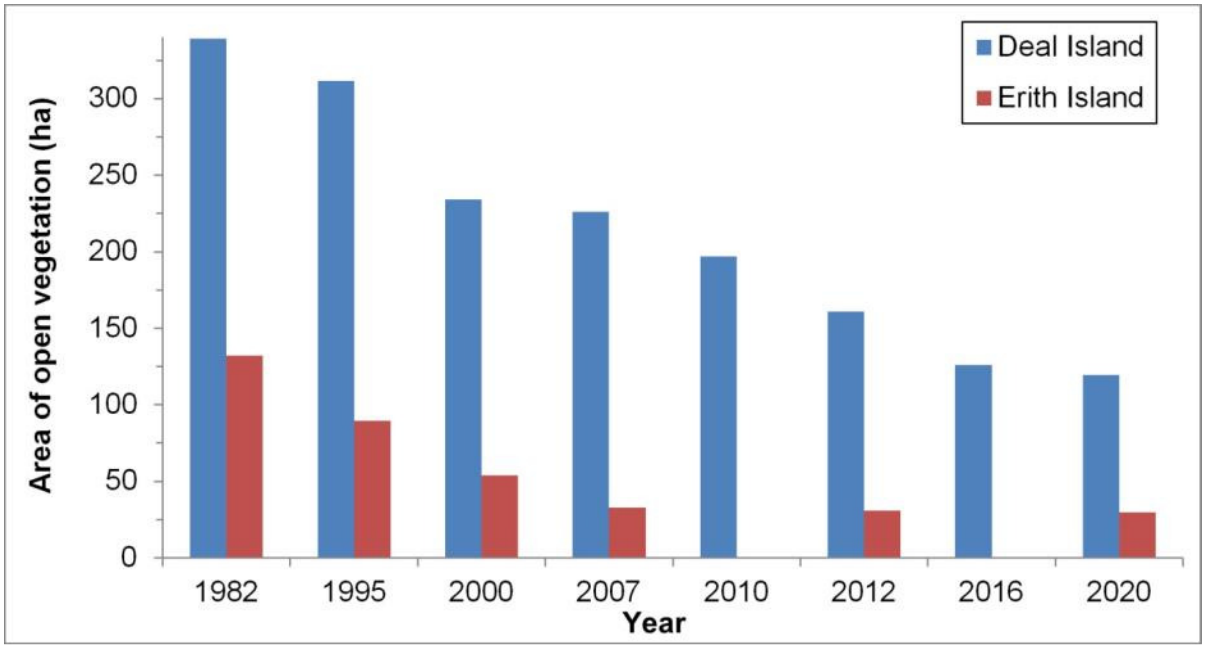


Figure 20. Reduction in the area of open grassland on Deal Island between 1982 and 2020.

Table 11. Area of grassland on Deal and Erith Islands and the rate of grassland loss.

	Deal Island		Erith Island	
Year	Ha	Loss/yr	Ha	Loss/yr
1982	339.3		132.2	
1995	311.5	2.1	89.6	3.3
2000	234.1	15.5	54.0	7.1
2007	226.0	1.2	32.9	3.0
2010	197.1	9.6		
2012	161.0	18.0	31.0	0.4
2016	126.2	8.7		
2020	119.4	1.7	29.9	0.1

On Deal Island, the majority of this vegetation change has been the result of she-oak forest expanding into grassland areas. This expansion is the result of both boundary expansion and in-filling by she-oaks as the result of longer range dispersal.

On Erith Island, most of the loss of grassland areas has been the result of expansion in the area of coast tea-tree, monotoca and myoporum.

The expansion of she-oak into grassland can be seen in Figures 21 and 22. Figure 21 shows a transect between she-oak closed forest and *Poa* grassland. On this transect, the boundary between she-oak dry forest and grassland between 1982 and 2020 has been plotted along with the cover and basal area of she-oak, and the cover of tussocks. Figure 22 shows the expansion of she-oak into grassland in the area to the east of the compound between November 2015 and December 2020.

On Deal Island, the rate at which the she-oak forest boundaries are expanding into grasslands is variable and averages about one to five metres per year.

This suggests that in the absence of fire and excluding areas with extreme levels of climatic exposure (mostly covered by low vegetation cover grasslands; see Table 7; Figure 16b), at the current rate, the majority of the Deal Island's grassland could be lost within the next 25 to 50 years. It also suggests that the majority of Erith Island's grassland could be lost within the next 15 to 25 years.

Over the southern half of Deal Island the change in vegetation has mainly been a structural change from low open types to taller and more closed types. This probably reflects vegetation recovery following the extensive 1972 fire.

Vegetation change mapping has not been performed for Dover Island. However, examination of the aerial photographs and satellite images (Table 1) suggests that major change has not occurred with the vegetation becoming taller and denser but not fundamentally changing in its type or location.

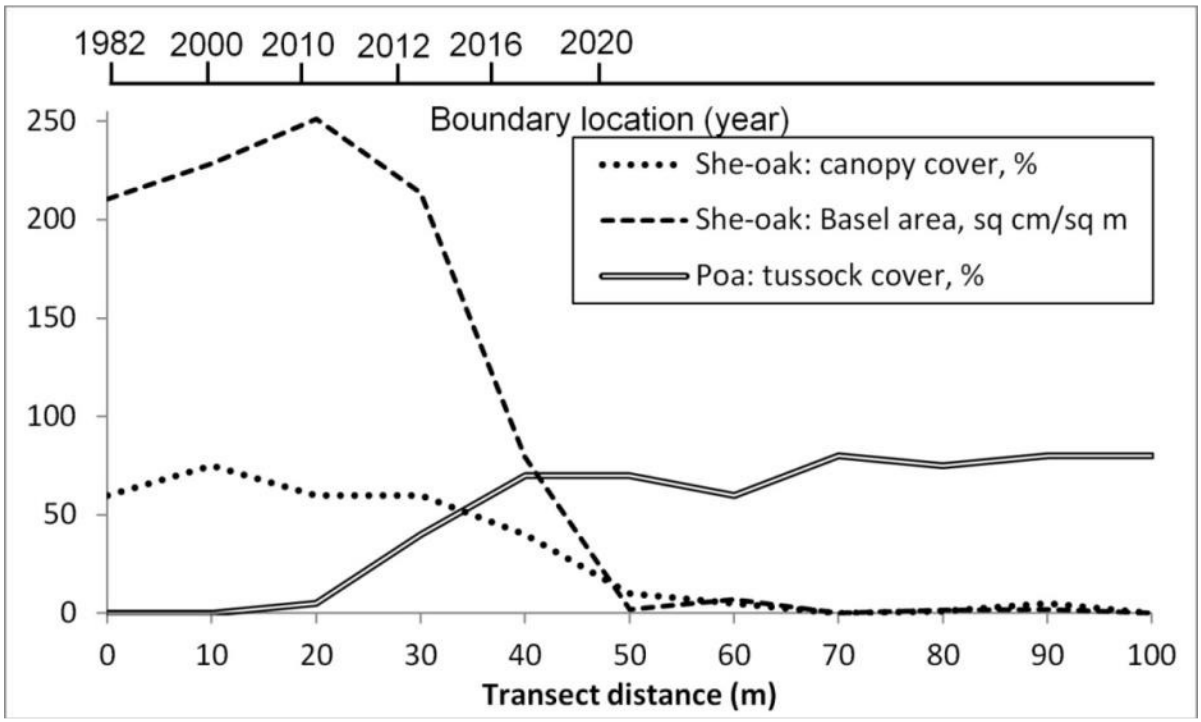


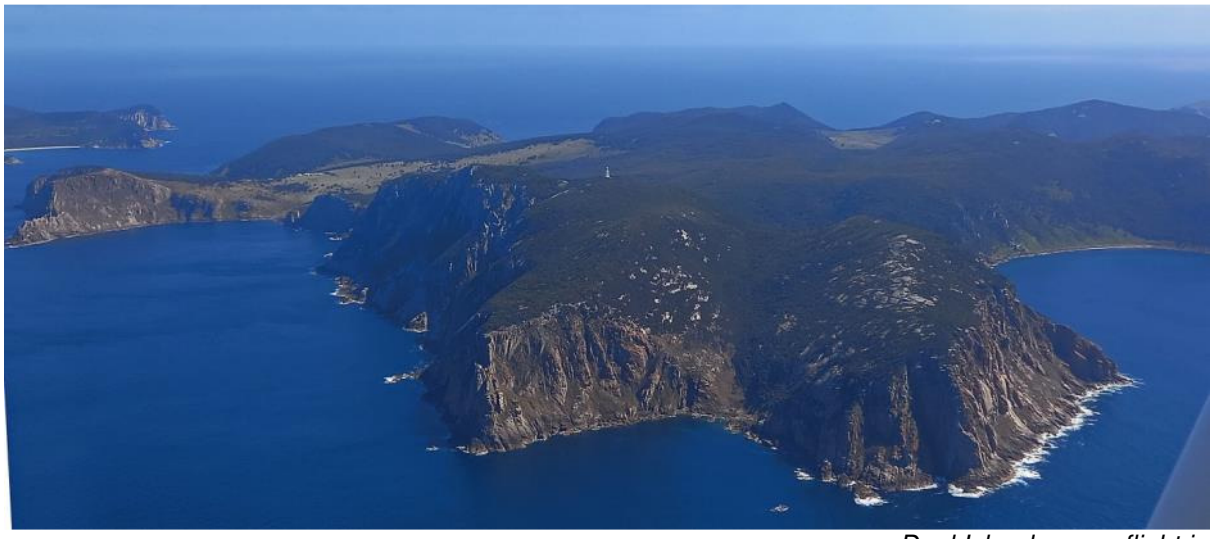
Figure 21. Expansion of she-oak into grassland on Deal Island between 1982 and 2020.

East Cove from the slopes of Barn Hill

a) November 2015

b) December 2020

Figure 22. Expansion in she-oak between Nov 2015 and Dec 2020. View from Barn Hill.



Deal Island on our flight in

4.7 Weed surveying and mapping

The weeds targeted for management on Deal Island were:

- ragwort *Senecio jacobaea*;
- sea spurge *Euphorbia paralias*;
- marram grass *Ammophila arenaria*;
- horehound *Marrubium vulgare*;
- great mullein *Verbascum thapsus*;
- arum lilies *Zantedeschia aethiopica*.

An issue during the past few years is that the FODI were unable to perform working bees during the early stages of the covid outbreak. Whilst this probably had minimal impact on the spread of ragwort due to ragwort's already widespread distribution, it probably resulted in an increase in the amount of sea spurge.

4.7.1 Weed management performed in December 2021 and January 2022

The first stage was an assessment of all recorded weed sites in December 2021 and January 2022. During this assessment, with the exception of ragwort, all of the target weeds found were removed.

In order to perform the first weeding stage, all of the available weed location data was collated and summarised. This data was obtained from the weed management plans prepared by FODI over the past 20 years[38], the mapping performed by JMS in November 2015 and February 2016 along with the point location data recorded by FODI during their working bees.

When the point location data was summarised, all of the sites not on Deal Island were deleted. For the remaining data, for each weed species all of the records within 15 m of each other were amalgamated to a single point, reducing the number of point records from 480 to 346. An additional 31 weed sites were recorded in December 2021 and January 2022, comprising two agapanthus, one horehound, 19 sea spurge, three ragwort and one marram grass site, making a total number of 377 sites to be assessed in the second stage of the weeding.

The previously recorded weed sites are shown in Map 12 and Appendix 3a.

Ragwort

With ragwort notes were made detailing ragwort amount and coverage, with only isolated outlier plants being removed. Ragwort was mapped as polygons with the exception of isolated patches which were mapped as point data.

Visual assessments of the ragwort treatment performed by FODI in November 2021 were made with the aim of estimating the resources required to control ragwort using herbicide spraying. This assessment involved walking through infested areas and making observations of dead versus live ragwort plants. The data collected included:

- location and size of infested areas;
- amount of mature and seedling ragwort;
- tussock density;
- site slope.

[38] Deal Island weed plans:
Deal Island weed plan 2002 - Mel Lambourne and Ahmet Bektas.
Deal Island weed plan 2009.
Progress with with weed management on Deal Island: 2002 - 2014. Friends of Deal Island.
Deal Island weed plan 2015 - Penny Tyson, Friends of Deal Island.

The kill rate of ragwort plants which had been sprayed in November 2021 was very high (close to 100%; Figure 23). However, it also appears that within treated areas a large proportion of the ragwort plants were missed. This would have been due to dense tussocks hiding the plants (average tussock cover, height and fuel load respectively of 85%, 78 cm and 18 t/ha; see Table 8) and due to the spraying being conducted early in the season when most plants were small and largely hidden. Overall, the estimated ragwort kill rate within treated areas was below ten percent.

Figure 23. Sprayed ragwort near the airstrip.

During the five days of spraying in November 2021 about 21% of the areas infested with ragwort were treated, with the steepest and highest density areas being left untreated. Assuming an effective kill rate in treated areas of ten percent, this means that the spraying resulted in killing about 750 ragwort plants (about 1.5% of the island's ragwort).

Sea spurge

In the case of sea spurge, all recorded plants were pulled and checked for seeds. When found, the seed bearing parts of the plants were removed and placed in the "remove from island rubbish". The location of all sea spurge plants which are likely to have dropped seed were GPS logged.

In December 2021 and January 2022, 52 mature and 2022 juvenile were pulled, making a total of 2074 sea spurge weeded (Table 12).

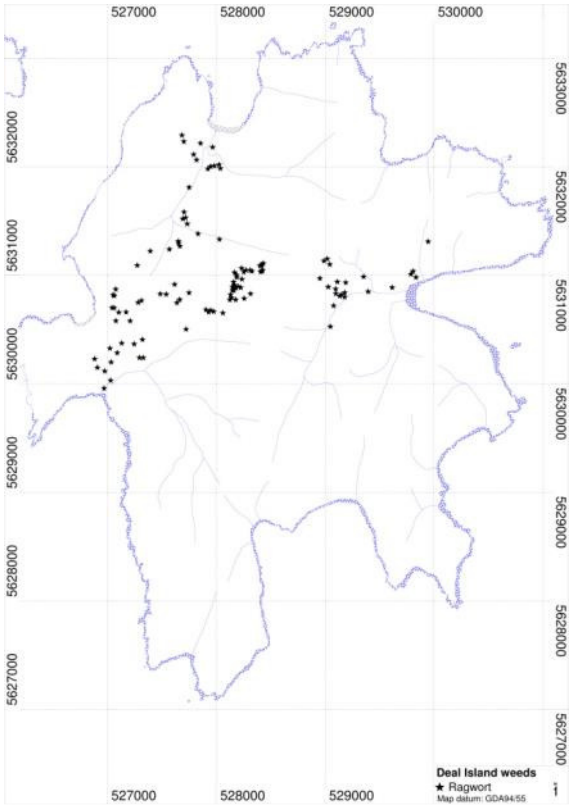
On Erith Island, sea spurge also occurs in small numbers on the main beach and in larger numbers at Wallabi Cove where it is being controlled by the Erith mob.

Other weeds

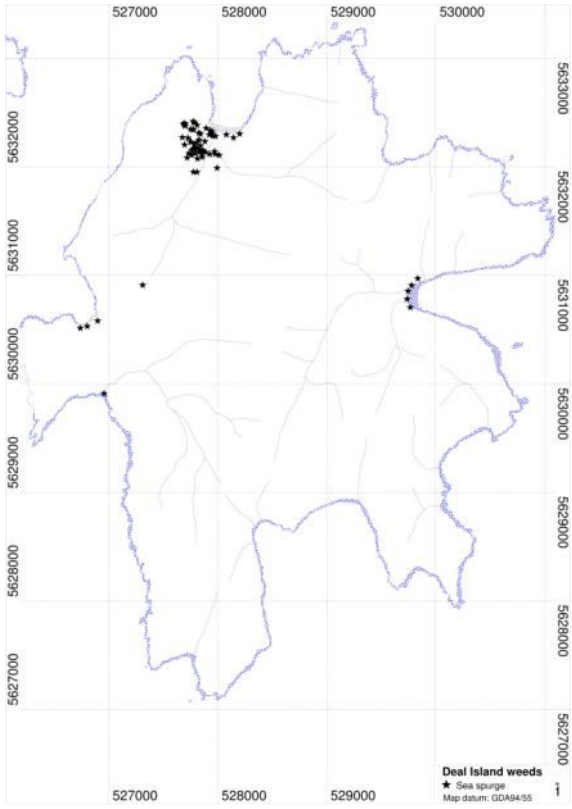
During December 2021 and January 2022 a total of one horehound, ~150 great mullein, ~100 scotch thistles and several hundred slender thistles were found and removed.

A small clump of marram grass was dug out from near the western end of the Garden Cove beach.

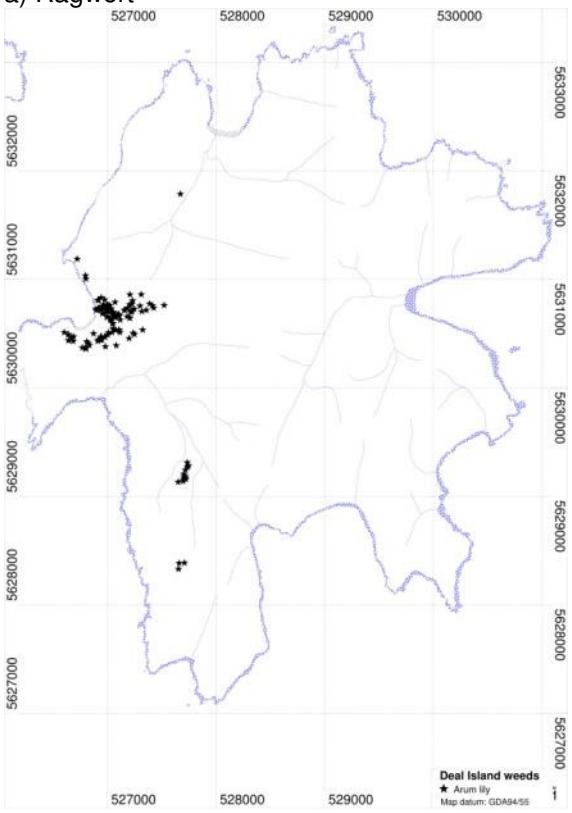
No arum lilies were found during the December and January weeding.



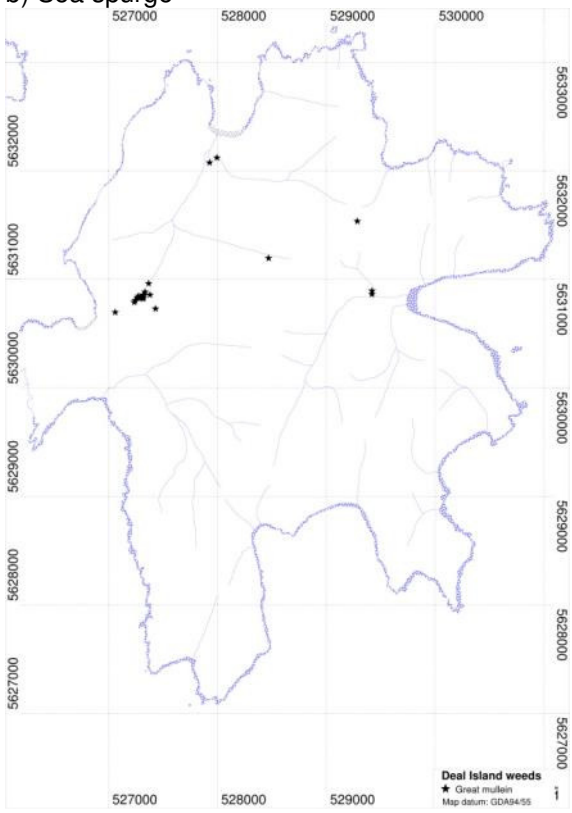
a) Ragwort



b) Sea spurge

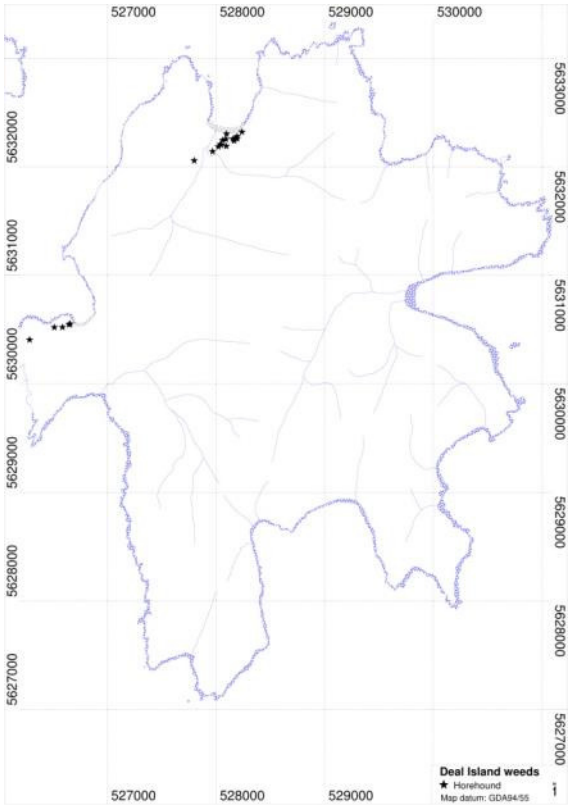


c) Arum lily



d) Great mullein

Map 12. Previously weeded sites.



e) Horehound

Map 12. Previously weeded sites, continued.

Anchor winch from the Karitane, wrecked Squally Cove 1922

4.7.2 Weeding management performed in February 2022

The second weeding stage involved checking the vicinity of the sites where weeds had been recorded within the preceding 12 months (ie during the past two FODI working bees and by JMS and GW over the 2021-22 summer).

Ragwort

The amount of ragwort on Deal Island peaked in early February, with plants dying back after this time and starting to release their seeds.

No effort was made to do large scale ragwort weeding, with only a number of small infestations behind Garden Cove and the lower compound being removed.

Sea spurge

The major problem areas for sea spurge are the grassland behind Garden Cove and the bank above East Cove. The Garden Cove sites cover an area of about ten hectares, go inland from the beach about 300 m and go up the western hillside to an altitude of about 70 m above sea level (ASL). At East Cove, seedlings are scattered across the entire steep part of the bank with a major outlier patch about 150 m south southwest and 50 m ASL from the East Cove jetty (Figure 24).

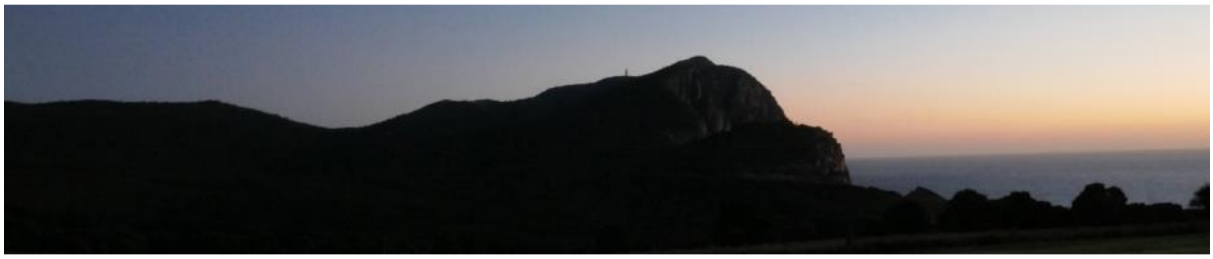
All sea spurge plants were pulled with any seed bearing parts of the plants being removed. A total of 220 mature and 1684 juvenile sea spurge plants were pulled, making a total of 1904 weeded sea spurge in February (Table 12).

Table 12. Sea spurge removed between December 2021 and February 2022.

	Dec 2021 to Jan 2022		Feb 2022	
Location	mature	juvenile	mature	juvenile
East Cove beach and fore-dune	2	207	0	14
East cove bank	9	1380	50	1020
Little Squally Cove	0	3	0	0
Garden Cove fore-dune east	0	23	0	15
Garden Cove fore-dune west	4	181	6	89
Garden Cove interior	37	205	164	541
Winter Cove	0	23	0	5
Total	52	2022	220	1684

Other weeds

Seven small (ie <20 cm tall with a single leaf) arum lilies were dug out (including the bulbs) from a previously recorded site which is located about 20 m uphill from the Telstra seat above East Cove.



Sunset from the compound looking towards the lighthouse

Figure 24. Sea spurge patch above East Cove.

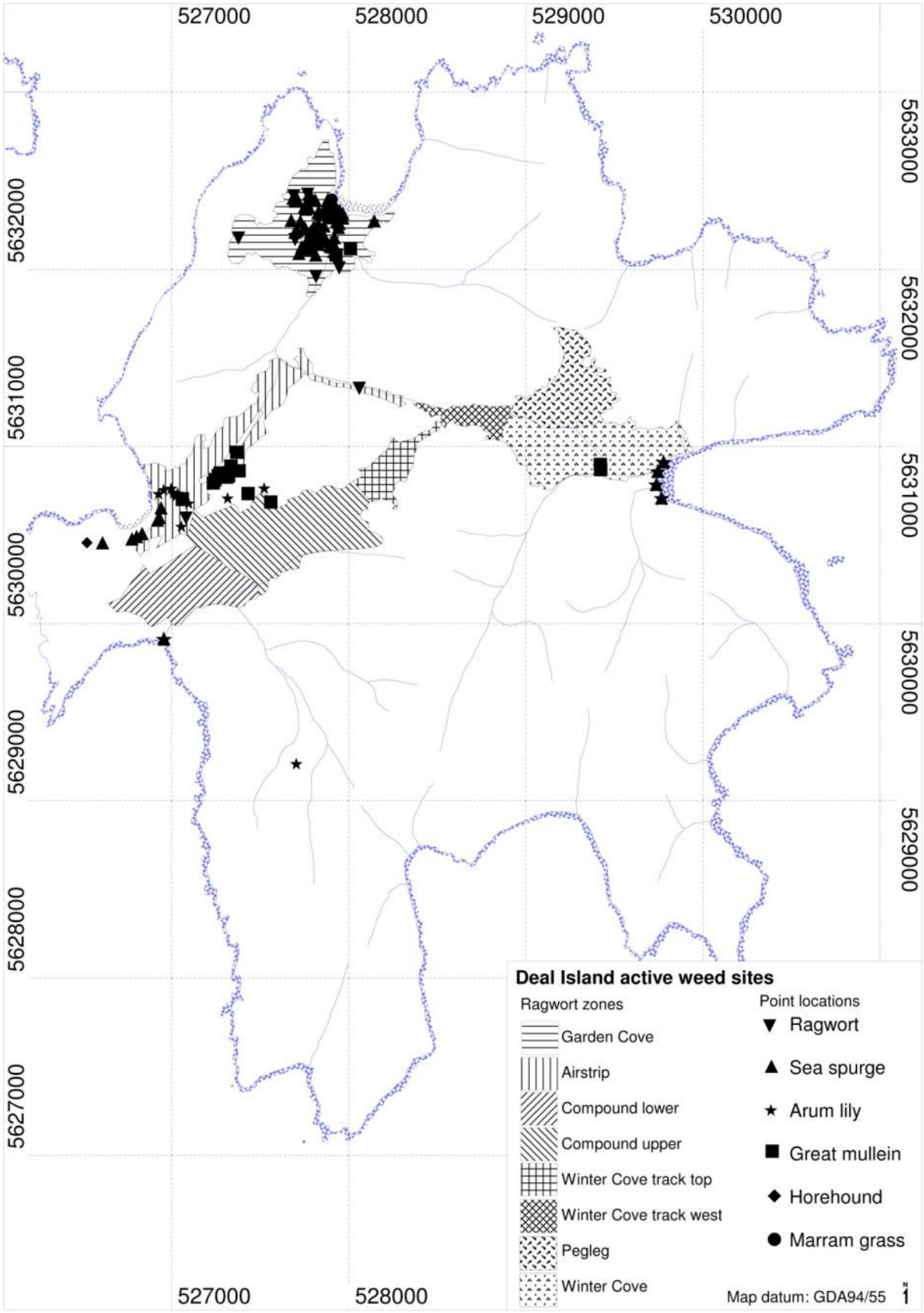
4.7.3 Active weed sites on Deal Island

Deal Island has been surveyed for weeds four times over the past 12 months (ie twice by each of FODI and us). Sites where weeds have been recorded during these surveys have been mapped, made up of 131 point locations and eight polygons.

The active weed point locations are made up of 14 arum lily, 19 great mullein, one horehound, one marram grass, 12 ragwort and 84 sea spurge. These sites are shown in Map 13 and the point location data is in Appendix 3b.

The active weed sites have been classified as either minor or major (Appendix 3b). Minor sites contain only juvenile and/or a few weeds. Major sites contain mature and/or a moderate to large number of weeds. In total, one arum lily, one great mullein and 15 sea spurge sites have been classified as major sites. All of the major weed sites require weeding at three month intervals in order to control the weed

infestations. The time required to do this weeding of major sites is about one day at East Cove and two days at Garden Cove.



Map 13. Active weed sites on Deal Island.

4.7.4 Assessment of weeds on Deal Island

Data collection and management

A critical aspect of weed management is the recording of comprehensive data and the analysis of the work performed so that the effectiveness of future work can be optimised. The easiest and most effective methodology for achieving this is to use of GIS and GPS technology to map weed locations and assist with the targeting previously located weed locations. While the use of GIS and GPS technology will not solve all weed management problems, it does have the potential to result in very large increases in weeding effectiveness.

This means that all weeders (or where people are working close together, each group) need to be equipped with GPS equipment and that the GPS units need to be downloaded and the data assessed in a timely manner (ideally each evening so that the each day's work can be assessed and the following day's work optimised).

A copy of the FODI GIS weed data was supplied prior to our caretaker period on Deal Island. Whilst it was possible to use the FODI data to determine past weed locations, it was not possible to determine how much had been weeded or when. The data also contained duplicates and untagged data points. During our weeding, we also found a significant number of sea spurge sites which had recently pulled plants but had no GPS point.

Use of biocontrol agents

Due to the scope of the weed problem on Deal Island along with the cost and logistical difficulty of performing large scale weed management, it is recommended that the strategy changeover to mainly rely on the use of biocontrol agents.

By themselves, biocontrol agents will not result in weed eradication. In order to be effective, biocontrol agents have to kill, or at least greatly reduce the target weed. This means if biocontrol agents are effective, they will be removed along with the target weed.

Biocontrol agents do, however, have the potential to reduce problem weeds to significantly lower levels, where weeds are no longer a threat to the ecosystem values and/or can be effectively treated using limited resources.

Ragwort

The most significant weed on Deal Island is ragwort.

Although ragwort occurs sporadically in she-oak dry forest, it is primarily a problem in the island's grasslands and she-oak woodland.

Over the past two decades the FODI group has been weeding ragwort, initially by hand removal and then in November 2021 by herbicide spraying using Lontrel (Clopyralid 600 g/l) at 50 ml per 15 l knapsack plus dye. In 2016 there were unsuccessful attempts to introduce ragwort biocontrol agents to the island.

Ragwort is rapidly expanding on Deal Island. As an example, JMS performed a ragwort survey in February 2016 as part of a FODI working bee, with the area infested by ragwort expanding by at least ten times and the number of plants by at least 50 times over the last six years.

It is estimated that there are over 15 000 adult and 35 000 juvenile ragwort plants on Deal Island. This will result in a massive seeding event during the 2021-22 summer.

With each adult plant producing 50 000 to 250 000 wind and gravity dispersed seeds, 100s of millions of seeds will be released over the coming months. This means that it is probable that many of the areas with low to moderate amounts of ragwort will shortly have significantly larger amounts of ragwort.

The amount of ragwort on Deal Island was estimated by mapping the area of grassland and she-oak woodland (see Section 4.4.2; Table 7 and Map 5) and then walking through each of these areas and subjectively estimating the percentage of the area which was in each of six density classes (Figure 25; Table 13). None of the areas surveyed were completely clear of ragwort.

a) Moderate density ragwort

b) High density ragwort

c) Very high density ragwort

d) Extreme density ragwort

Figure 25. Ragwort density classes.

Table 13. Ragwort density classes and treatment rates.

	Number/ha		Weeding rate
	mature	juvenile	m^2/hr
Very low	≤1	≤10	~10000
Low	~50	~100	~5000
Moderate	~100	~250	~2500
High	~250	~500	~1000
Very high	~500	~1000	~500
Extreme	~1000	~2500	~250

Table 13 also shows an estimate of the rate at which different areas could be surveyed and the ragwort sprayed. This spraying estimate was based on the assumption that it will be necessary to systematically walk transects through all of the areas searching for ragwort, with these transects being a maximum of ten metres apart due to the density of tussocks. If the transects are more than about ten metres apart it is almost certain that a large proportion of the ragwort plants will be missed. The speed at which transects could be walked through the tussocks was estimated using a GPS.

The majority of the higher density ragwort infestations are located in steep to very steep areas near the Pegleg track, Winter Cove and the southeast parts of the Compound upper zones (Table 14). All of these areas have very dense tussocks.

Table 14. Proportion and area of ragwort in the different zones.

	Area	Density class (%)						Area of each density class (ha)					
Zone	ha	VL	L	M	H	VH	E	VL	L	M	H	VH	E
Garden Cove	32.1	99	1	0	0	0	0	31.7	0.3	0.0	0.0	0.0	0.0
Airstrip	28.4	60	30	5	5	0	0	17.0	8.5	1.4	1.4	0.0	0.0
Compound lower	20.4	97	2	1	0	0	0	19.8	0.4	0.2	0.0	0.0	0.0
Compound upper	35.8	50	20	15	10	5	0	17.9	7.2	5.4	3.6	1.8	0.0
Winter Cove track top	7.8	44	35	15	5	1	0	3.4	2.7	1.2	0.4	0.1	0.0
Winter cove track west	5.4	44	25	25	5	1	0	2.4	1.3	1.3	0.3	0.1	0.0
Pegleg	16.9	15	15	15	25	15	15	2.5	2.5	2.5	4.2	2.5	2.5
Winter Cove	27.9	25	20	15	15	15	10	7.0	5.6	4.2	4.2	4.2	2.8
Total areas (ha)	174.7							101.8	28.6	16.2	14.1	8.7	5.3

Using the estimates in Tables 13 and 14, the time required to spray the ragwort on Deal Island has been estimated (Table 15).

Table 15. Time required to treat the Deal Island ragwort.

		Hours to treat different areas						Total	
Zone	Area	VL	L	M	H	VH	E	hrs	days
Garden Cove	32.1	32	1	0	0	0	0	32	5
Airstrip	28.4	17	17	6	14	0	0	54	9
Compound lower	20.4	20	1	1	0	0	0	21	4
Compound upper	35.8	18	14	21	36	36	0	125	21
Winter Cove track top	7.8	3	5	5	4	2	0	19	3
Winter cove track west	5.4	2	3	5	3	1	0	14	2
Pegleg	16.9	3	5	10	42	51	102	212	35
Winter Cove	27.9	7	11	17	42	84	112	272	45
Total	174.7	0	0	0	0	0	0	751	125

Note: days required to survey and spray the ragwort assume a six hour working day and no days lost due to adverse weather

It needs to be noted that this surveying and spraying will be laborious and will require very fit people who are willing to do day after day of very hard work. It will also be necessary for all of the people performing the searching and spraying to carry GPS

units so that the GPS track logs can be checked at the end of each day in order to ensure all areas have been treated.

In addition, due to the amount of ragwort and since ragwort is wind dispersed, there is little point weeding limited parts of Deal Island without weeding all areas. If limited area weeding is attempted then it is almost certain that ragwort will reinvade from unweeded areas.

About 125 person days of on-the-ground work will be required in order to survey and treat the island's ragwort. Assuming a team of five people, realistically this means that a deployment of at least a month will be required once the time required to get to and from the island, days off and adverse weather are taken into account. Additional time will also be required for any other jobs on the island that need to be performed.

The surveying and spraying will then need to be repeated at least annually for several years. These subsequent spray treatments will not be significantly quicker than the initial treatment due to the requirement to comprehensively search all areas. In addition, funds will be required for sprayers (each person will need to carry a two or four litre sprayer) and herbicide, but these funds are likely to be minor compared to the funds required to get people on and off the island.

No estimate has been made as to whether the personnel and funds required to perform this work are available. However, this work will require a major increase above what the PWS and FODI have been utilising for working bees on Deal Island.

There are three biocontrol agents currently approved for use on ragwort in Tasmania. When all three are used together, these agents have the potential to reduce ragwort infestations by up to 95%. These agents are the ragwort flea beetle (*Longitarsus flavicornis*), ragwort stem and crown boring moth (*Cochylis atricapitana*) and the ragwort plume moth (*Platyptila isodactyla*)[39].

It is strongly recommended therefore that no further attempts be made to control ragwort on Deal Island using hand weeding or herbicide spraying, and that the resources that would have been used are utilised to source and spread ragwort biocontrol agents.

At the current time it appears that ragwort has not spread to Erith Island and it is critical that it is controlled on Deal Island before it does.

Sea spurge
Sea spurge is an ongoing problem on Deal Island.

Although the amount of sea spurge has been greatly reduced from the levels that prevailing 20 years ago, sea spurge is still common in the grassland behind Garden Cove and on the bank above East Cove (Table 12).

Compared to November 2015 and February 2016 when JMS attended FODI working bees the amount of sea spurge on the East Cove bank has been reduced by about half. However, at Garden Cove the number of seedlings has remained about the same, while the number of mature plants has increased by about four times with these mature plants being much more dispersed.

[39] Tamar Valley Weed Strategy. See: https://www.weeds.asn.au/weed-control/biological-control/ragwort-flea-beetle/.

There are a number of probable reasons for this and it is unlikely that sea spurge will be controlled on Deal Island using the current management strategy.

Firstly, in places like Deal Island sea spurge has very rapid growth rates and reaches maturity by the age of six months. This means that weeding needs to be performed every four to six months in order to stop the plants producing seeds.

Secondly, when weeding is performed it is critical that all infested areas be surveyed and all mature and immature plants removed.

Thirdly, all sea spurge plants need to be removed, mature plants effectively killed and any all seed bearing parts of plants removed from the site. Whilst we were doing our weeding of sea spurge over the 2021-22 summer we frequently encountered previously pulled mature sea spurge plants which appeared to have not had their seed bearing parts removed (Figure 26a). This means that if these plants had had any seeds on them, the seeds would have fallen, germinated and perpetuated the infestation. In addition, when large mature sea spurge plants are pulled, it is common that the plants break off at the ground surface. These plants then quickly re-sprout and rapidly produce multi-stem seed producing plants (Figure 26b). When plants are pulled, it is critical that at least five centimetres of the plant's root below the base of the red part of the stem be removed and if possible, at least 15 cm of root.

a) Pulled sea spurge plant with intact top section b) Re-sprouted sea spurge plant

Figure 26. Previously pulled sea spurge plants.

This requirement to pull sufficient amounts of the plant's roots was a major finding from the SPRATS group[40] where observations of pulled sea spurge over several seasons resulted in weeding groups being instructed on how to pull the plants.

Lastly, due to sea spurge's ability to rapidly germinate and replenish its seed bank, it is critical that when plants are found their location is logged so that targeted follow-up weeding can be conducted. The easiest way to perform this is for each person to carry a hand-held GPS (or have a GPS for each group of people if working within 25 to 50 m of each other). The data from these GPS units can then be downloaded and collated. Ideally, this post-weeding assessment should be done each evening during the working bee to allow for follow-up weeding and to ensure all areas have been adequately covered.

If sea spurge is to be controlled on Deal Island, there are two options: get caretakers to undertake weeding of the major sites at three month intervals and/or introduce the

[40] SPRATS: Sea Spurge Remote Area Teams, WildCare group working to weed the 850 km of coastline between Macquarie Harbour and Cockle Creek on Tasmania's west and south coasts.

recently approved sea spurge biocontrol. If caretakers are to be tasked with weeding, they will need to be supplied with a programmed GPS unit and weed maps. If Garmin GPS units are used, the GPS can be easily updated with the latest data using GPX format files which can be emailed to the caretakers.

The sea spurge bio-control agent has been extensively researched and approved for release[41] in Tasmania. This bio-control consists of a fungus, *Venturia paralias,* which has been demonstrated to be highly sea spurge specific (and weakly infective to one other introduced weedy spurge). The bio-control was isolated from sea spurge's native range on the Atlantic coast of France. The bio-control normally infects sea spurge through leaf lesions which then spread to the stem, girdling it and causing stem collapse (Figure 27). The leaf lesions typically form about two weeks following infection[42].

Figure 27. Biocontrol stem lesion on a sea spurge plant. Photograph: CSIRO Canberra.

Sea spurge has no closely related species in Australia, with all native Australian *Euphorbia* spp. being in a different sub-genus to sea spurge. This means that it is extremely unlikely that the bio-control will spread to and infect native species.

The current status of the sea spurge biocontrol is that in late October 2021 JMS performed three test releases in Tasmania at Low Head and Bakers Beach on the north coast and at Duck Creek on the west coast. The aim of these test releases was to determine the optimum strategy for spreading and establishing the agent and it is anticipated that there will be large scale Tasmanian releases in the second half of 2022.

Other weeds

All of the other target weeds on Deal Island are under control and only require on-going monitoring to ensure they do not become a problem again.

[41] Final risk analysis report for the release of *Venturia paralias* for the biological control of *Euphorbia paralias.* See: https://www.agriculture.gov.au/biosecurity/risk-analysis/biological-control-agents/risk-analyses/completed-risk-analyses/ra-release-venturia-paralias.

[42] Hunter GC, Zeil-Rolfe I, Jourdan M, Morin L 2019. Information package to support application to release the fungus *Venturia paralias* for the biological control of sea spurge (*Euphorbia paralias*) in Australia. CSIRO.

4.8 Rare and threatened communities and species

From an ecological perspective, maximising biodiversity in fire dependent vegetation types (ie the majority of Deal Island's vegetation associations) requires fire frequencies of between about five and 30 years (see Marsden-Smedley 2009; Marsden-Smedley and Sherriff 2014)[43]. This means that all of Deal Island's vegetation types are considered to be long unburnt and that it is likely that a fire (either bushfire or planned burn) would result in enhanced biodiversity and highly unlikely to result in adverse ecological impacts.

Information on rare and/or threatened community types and species was obtained from the Natural Values Atlas (NVA).

The fire dynamics of Tasmania's rare and/or threatened vegetation types and species have been reviewed by an expert panel. This panel used the fire-attributes vegetation types published by Pyrke and Marsden-Smedley (2005) and made recommendations as to the communities and species fire requirements, fire sensitivities and flammabilities (see EcoTas 2018a, 2018b; FPA 2017a; 2017b)[44].

4.8.1 Threatened plant community types

In the Kent Group, four threatened plant communities have been recorded on the TasVeg map and NVA (Table 16).

Table 16. Threatened vegetation types mapped by TasVeg in the Kent Group.

Id	TasVeg mapped community type	Actual vegetation type	Island(s) recorded on
26	SCL heathland on calcareous substrates	dry scrub	Deal Is, Erith Is
30	NME *Melaleuca ericifolia* swamp forest	wet scrub, dry scrub	Deal Is, Erith Is, Dover Is
35	SRH seabird rookery complex	grassland or dry scrub	Deal Is
36A	SSZ spray zone coastal complex	bare ground: rock or low grass cover	Deal Is

The listed rare community type, heathland on calcareous substrates, has been mapped by TasVeg. In the Kent Group the vegetation mapped as this type is a tall dry scrub and should have been mapped as coastal heathland (type SCH), coastal scrub (type SSC) or coastal scrub on alkaline sands (type SCA). These vegetation types are highly fire tolerant and unlikely to be adversely impacted by periodic fire.

[43] Marsden-Smedley JB 2009. Planned burning in Tasmania: operational guidelines and review of current knowledge. Parks and Wildlife Service, Tasmania.

Marsden-Smedley JB and Sherriff LJ 2014. Planned burning manual - guidelines to enable safe and effective planned burning on private land. NRM North, Launceston Tasmania.

[44] ECOtas 2018a. Managing Threatened Vegetation Communities in Areas Proposed for Fuel Reduction Burning. Background Document 1: Project Overview, Terminology, Legislative & Policy Context, and Development of Management Recommendations. Report by Environmental Consulting Options Tasmania (ECOtas) for Tasmania Fire Service.

ECOtas 2018b. Managing Threatened Vegetation Communities in Areas Proposed for Fuel Reduction Burning. Background Document 2: Literature Review, Specialist Consultation and Management Guidelines. Report by Environmental Consulting Options Tasmania (ECOtas) for Tasmania Fire Service.

FPA 2017a. Managing threatened flora species in areas planned for fuel reduction burning. Background document 1: project overview, key terms and legislation. Forest Practices Authority, Hobart, Tasmania.

FPA 2017b. Vegetation associations, impact of fires and management recommendations: supporting information for the vegetation association codes, impact of fire information and management recommendations provided to Tasmania Fire Service in excel format. Forest Practices Authority, Hobart, Tasmania.

While the threatened community types, seabird rookery complex and spray zone coastal complex have been recorded on Deal Island, the TasVeg mapped areas appear to have been mapped randomly and do not reflect the actual distribution of these vegetation types.

While seabird rookery complex and spray zone coastal complex occur on all of the island's coastal fringes (mostly as penguin rookeries or steep highly exposed cliff lines) their areas are too small to be mapped at the scale of the mapping in this report (or the TasVeg map). These vegetation types are moderate to highly fire sensitive due to fire's impact on nesting birds, and fire should be minimised wherever possible. For example, on Deal Island there are penguin rookeries at East Cove, Little Squally Cove, Squally Cove, Winter Cove and Garden Cove, with these rookeries having an estimated combined area of about two hectares.

The threatened vegetation type, *Melaleuca ericifolia* swamp forest, has been mapped by TasVeg on Deal, Erith and Dover Islands. All of these areas have been mis-mapped. On Deal Island, these areas are *Melaleuca* wet scrub (Tables 7 and 8; Map 5), which is closer to the TasVeg types wet heathland or *Melaleuca squarrosa* scrub than swamp forest. On Erith and Dover Island, all of the mapped areas occur in sites with moderate to steep, well drained slopes and are a dry scrub community dominated by tea-tree and paperbark.

This means that all of the threatened community types mapped by TasVeg in the Kent Group are either incorrectly mapped (ie *Melaleuca ericifolia* swamp forest) or their locations and sizes do not reflect on-the-ground vegetation distributions. None of the vegetation types mapped by this report (Tables 7 and 8; Figures 5 to 16; Map 5) would be classified as a threatened vegetation type.

4.8.2 Rare and threatened species

A total of 18 plant and four animal rare or threatened species have been recorded in the Kent Group (Table 17). Information on the fire dynamics of these rare and threatened species have been summarised from a spreadsheet produced by the Forest Practices Unit (FPA 2017b).

Juvenile Pacific gull at Garden Cove

Table 17. Rare and/or threatened species recorded in the Kent Group.

	Species	Common name	Schedule	
			state	national
Flora	*Caladenia aurantiaca*	orangetip fingers	e	
	Caladenia prolata	white fingers	e	
	Caladenia pusilla	tiny fingers	r	
	Centrolepis strigosa subsp. *pulvinata*	Bassian bristlewort	r	
	Chenopodium erosum	papery goosefoot	x	
	Cotula vulgaris var. *australasica*	slender buttons	r	
	Cyrtostylis robusta	large gnat-orchid	r	
	Gyrostemon thesioides	broom wheelfruit	r	
	Hydrocotyle comocarpa	fringefruit pennywort	r	
	Parietaria debilis	shade pellitory	r	
	Pellaea calidirupium	hotrock fern	r	
	Pomaderris paniculosa subsp. *paralia*	shining dogwood	r	
	Pterostylis sanguinea	banded greenhood	r	
	Solanum opacum	greenberry nightshade	e	
	Stellaria multiflora subsp. *nebulosa*	nebulous rayless starwort	r	
	Triglochin minutissima	tiny arrowgrass	r	
	Xanthoparmelia microphyllizans		r	
	Zygophyllum billardierei	coast twinleaf	r	
Fauna	*Gazameda gunnii*	Gunn's screw shell	v	
	Haliaeetus leucogaster	white-bellied sea-eagle	v	
	Parvotettix whinrayi	Whinray's cave cricket	r	
	Thinornis rubricollis	hooded plover		V

Note: e=endangered, r=rare, v=vulnerable, x=extinct; state schedule in lower case, national schedule in capitals.

Orangetip fingers is restricted to Deal Island and its response to fire is poorly known but it grows in fire-prone vegetation and similar orchid species respond well to high intensity fires.

The fire response of white fingers is poorly known but it grows in fire-prone vegetation types and similar orchid species respond well to high intensity fires.

Tiny fingers are promoted by fire.

Bassian bristlewort is promoted by disturbance and unlikely to be adversely impacted by fire.

Papery goosefoot was collected from the Kent Group in 1804, has not been recorded since and is presumed extinct.

Slender buttons grows in saline herbfields, rocky coastal outcrops, and wet or brackish swamps and is unlikely to be adversely impacted by fire.

Large gnat-orchids and Broom wheelfruit occur in coastal or near-coastal sites on well-drained soils, often with she-oak with no further information being available.

Fringefruit pennywort has been recorded on Deal Island from penguin track-ways and bare soil and is unlikely to be adversely impacted by fire.

Shade pellitory occurs in rookeries, on cliffs or rocks in the salt spray zone, in moist shaded areas in dune scrub and under rock overhangs with no further information being available.

Hotrock ferns grow in crevices and on ledges on exposed or semi-exposed rock outcrops with no further information being available.

Shining dogwood grows in exposed sites along cliff lines, on dunes, in coastal heathland and scrub and in low forest dominated by she-oak with no further information being available.

Banded greenhood grows in coastal eucalypt and she-oak woodland, teatree scrub and scrubby heathland with no further information being available.

Greenberry nightshade grows in a variety of habitats, including poorly-drained tall Melaleuca swamp forest, Melaleuca - coast tea-tree dry scrub and in open shrubberies on granite outcrops.

Greenberry nightshade is short-lived and likely to be dependent on periodic disturbance, including being burnt.

Nebulous rayless starwort is poorly known but appears to be fire dependent and promoted by burning.

Tiny arrowgrass occurs in fresh or brackish mudflats or margins of swamps, mostly coastal areas and is unlikely to be adversely impacted by fire due to its habitat not being fire prone.

Xanthoparmelia microphyllizans occurs on granite rocks on Deal Island in the Kent Group with no further information being available.

Coast twinleaf occurs on calcareous sands, forests, wetlands and heath communities on the Furneaux Group and is highly resistant to disturbance and probably promoted by fire.

There is no fire regime information available for Gunn's screw shell.

White-bellied sea-eagles are sensitive to disturbance during breeding season (July to February). The Pulpit Rock sea eagle nest is unlikely to be impacted by fire due to its location on a rock cliff face but bushfires during dry conditions could potentially spot into and ignite the nest’s sticks (see Figure 31). It is not known whether the sea eagle pair has other nests elsewhere in the Kent Group.

There is no fire regime information available for Whinray's cave cricket.

Due to hooded plover’s habitat being mainly on beaches, they are unlikely to be impacted by fire. During our stay on Deal Island, no hooded plovers were seen.

This means that, with the exception of Papery goosefoot which is probably extinct, all of the rare and/or threatened plant species in the Kent Group either grow in fire prone environments (and are hence probably adapted to periodic fire), grow in areas containing natural fire refuges (eg rocky areas) or grow in areas unlikely to burn (eg wetlands).

As regards rare and/or threatened animal species, the major species of concern are sea eagles. However, due to its nest location on a cliff edge there is little that can be done to protect this nest.

The other rare and/or threatened animal species either have no fire information available (ie Gunn's screw shell and Whinray's cave cricket) and or live in non-fire prone habitats (ie hooded plover).

In addition to the listed rare and threatened communities and species, the issue of vegetation change needs to be considered. On both Deal Island and Erith Island, very rapid vegetation change is occurring which, if it continues at the current rate will see the majority of the islands open grasslands transformed into she-oak forest or dry scrub within the next 15 to 50 years (see Section 4.6). If any of the rare or threatened species are dependent on these grasslands then it is likely that they will be adversely impacted.

4.9 Bushfire risk assessment

The aim of this bushfire risk assessment is to provide guidance on the relative levels of bushfire risk on Deal Island. It has been conducted for the following areas:

- compound containing the caretaker and visitor houses, museum and workshop;
- lighthouse precinct;
- main access tracks, and;
- Winter Cove kayaker's campsite.

4.9.1 Risk assessment inputs

The main inputs used to assess bushfire risk are the average weather conditions, ignition risk, level of fuel hazard, BAL ratings of the island's buildings along with the rare and/or threatened vegetation types and species that occur on the islands.

Weather

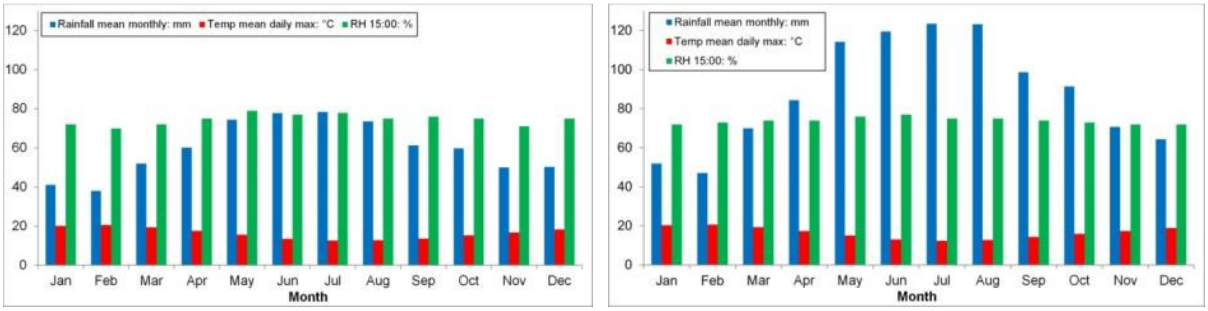
Weather data applicable to Deal Island is available from the Bureau of Meteorology (BoM) website[45].

Between 1984 and 1998, the BoM operated an automatic weather station (AWS) in the Deal Island compound (station 099001) with rainfall continuing to be collected until the current time. In addition to the Deal Island weather data, the BoM currently operates AWS on Wilsons Promontory (station 085096), Hogan Island (station 200838) and Flinders Island airport at Whitemark (station 099005).

Figures 28a and 29a show information on Deal Island monthly average rainfall, along with 15:00 temperature, relative humidity (RH), wind speed and wind direction.

The Deal Island AWS temperature, relative humidity and wind data needs to be used with caution due to the AWS having been discontinued about 25 years ago. However, the advantage of the data having been collected from the compound area means that it probably provides the most applicable weather data. As a comparison, the current AWS data from the BoM Wilsons Promontory AWS is shown in Figures 28b and 29b.

As can be seen from Figures 28a and 29a, Deal Island has year round high RH (average yearly RH about 75%), moderate wind speeds predominately from the northwest, west and south (average yearly wind speed about 26 km/hr) with calm weather being was recorded less than 0.5% of the time.

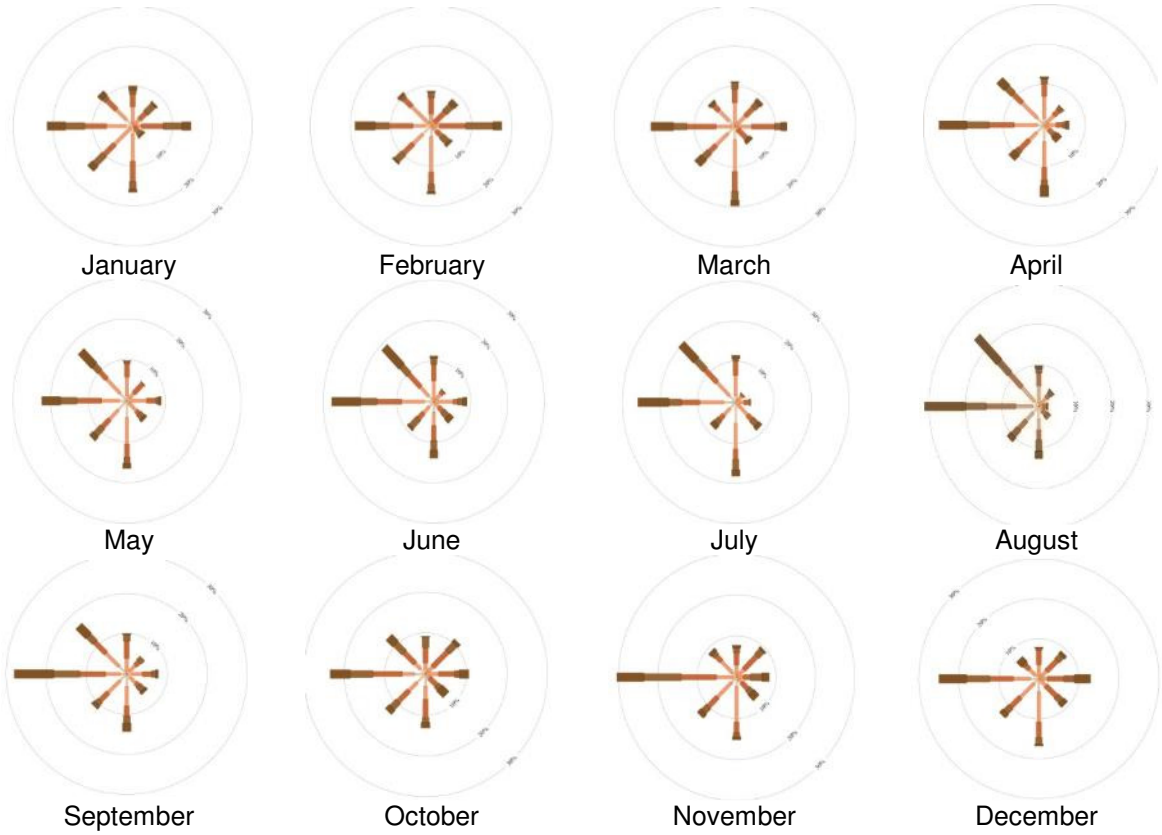


a) Deal Island AWS. Note: temperature and RH recorded between 1984 and 1998.

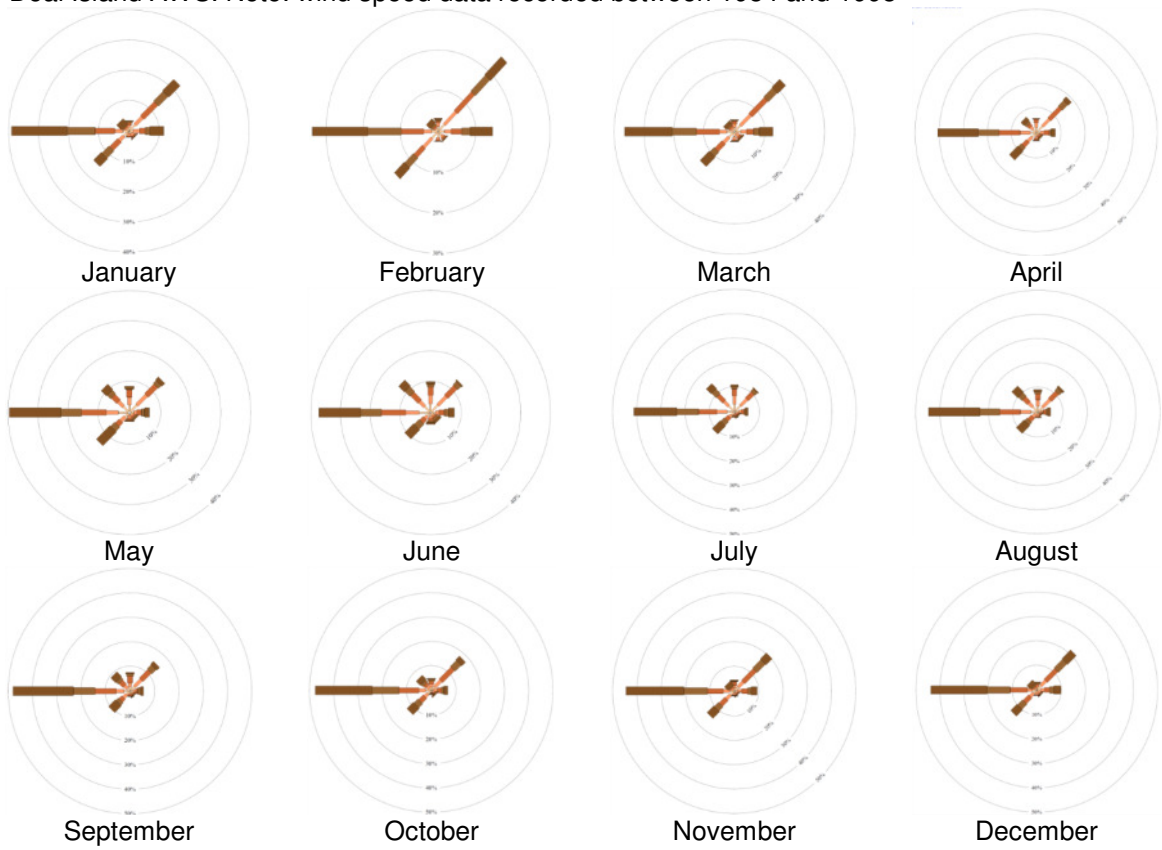
b) Wilsons Promontory AWS.

Figure 28. Average monthly rainfall, maximum temperature and 15:00 relative humidity recorded at the Bureau of Meteorology Deal Island and Wilsons Promontory weather stations.

[45] BoM AWS data: http://reg.bom.gov.au/climate/averages/tables/ca_tas_names.shtml.



a) Deal Island AWS. Note: wind speed data recorded between 1984 and 1998



b) Wilsons Promontory AWS.

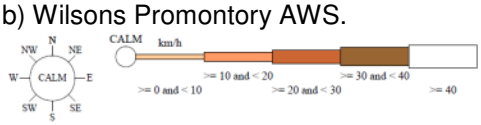


Figure 29. Average 15:00 wind speed and direction on Deal Island and at Wilsons Promontory.

Fire ignition risk

The fire history on Deal Island is only partly known (see Section 4.5).

However, from the information that is available it appears that there have been at least eight bushfires over the past about 70 years, with at least three (and possibly up to six) of these bushfires causing major impacts. This suggests it would be reasonable to assume that on average, bushfires occur about every nine or ten years. The mapped fire history also indicates that over the past 50 years, on average about 52 ha per year was burnt, although it needs to be noted that there have been no recorded fires on Deal Island over the past 28 years.

In the past, the majority of bushfires on Deal Island were ignited by people. However, over the past several decades there has been a marked increase in dry lightning caused fires in Tasmania (note that the 1951 and possibly 1972 fires were started by lightning). This means that there is a significant on-going fire ignition risk on Deal Island.

The other main fire ignition risks are ignitions caused by the Polaris ATV and mowers, escaped fires from campfires and/or the East Cove BBQ, and non-emergency use of flares during social events (mainly at East Cove and probably during significant events such as new year's eve).

The ATV is a significant fire risk. The main fire risk with the ATV appears to result from fuel system failures (often following roll-overs) and there have been a number of vehicle recalls addressing this issue. It also appears that ATV fires have occurred as the result of vegetation build-up near the exhaust. When we were using the AVT we frequently smelt burning vegetation but were unable to confirm the source. With hindsight, what we probably smelt was dead grass being burnt off the vehicle's exhaust. This means it is important to remove any build-up of dead grass from the vehicle's bash-plates, especially after mowing.

The mowers and brush-cutters used to manage the island's compound, airstrip and access tracks are also a potential ignition source. These ignitions could result from refuelling hot mowers and brush-cutters and/or from sparks igniting the grass during periods of elevated fire danger.

Fuel hazard rating

Currently, nearly three quarters of Deal Island has high to very high levels of FHR. However, the grassland areas adjacent to the compound have very high to extreme levels of FHR (Table 10, Maps 6 to 10).

Within the compound, the level of fuel hazard is very low and bushfires would only sustain within the compound under moderate to high wind speeds when conditions are very dry.

Fire danger rating

The BAL system specifies that bushfire risk in Tasmania should be assessed at a fire danger rating (FDR) of 50[46]. Even though Deal Island has typically high humidity and mild temperatures (Figure 28a), the high average wind speeds on Deal Island (Figure 29a) means that using a FDR of 50 is reasonable.

[46] See Table 2.6 in: AS3959-2018. Australian standard for construction of buildings in bushfire-prone areas. Standards Australia.

Planned burning

Currently there are no plans to perform planned burning on Deal Island. If planned burning was proposed the major impediment would be the logistics of getting fire personnel and equipment on and off the island in a timely manner so that the burning could be performed safely.

If a decision is made that the open grasslands need to be maintained, the invasion by she-oaks needs to be reduced (see Section 4.6). Planned burning is the only practical methodology by which this could be achieved. This burning could be performed as unbounded grassland burns which would also have the added benefit that if performed adjacent to the compound, the burns would lower the level of fuel hazard and reduce the level of fire risk to the caretakers and the public.

However, the amount of ragwort in the island's open grasslands is currently rapidly increasing. Fire would have the effect of further increasing the amount of ragwort, although it would open up the grassland and make it easy to subsequently find and spray the ragwort.

If planned burning was performed, the guidelines and objectives in Boxes 4 and 5 are recommended.

BAL ratings

The slope of the grassland outside the compound's fencelines along with the distances between the grassland and the houses were measured in order to determine the houses' BAL rating.

The grassland slopes on the outside of the compound's northwest and southeast boundaries respectively are a downslope of about 13° and 5°. The slopes on the compound's northeast and southwest boundaries are less than 5°. The distance between the compound fencelines and the houses was about 40 m on the northwest side and about 50 m on the southeast. This indicates that the caretakers and visitors houses require an effective BAL rating of 12.5.

Both the caretaker and visitor houses have been fitted with plastic insect screens. These screens should be upgraded to metal (metal screens would also be more robust and better resist the damage caused by possums).

In the BAL system, grasslands are assumed to have a fuel load of 4.5 t/ha. The actual grassland fuel load in the island's grasslands average about 18 t/ha (Table 9). This means that the assessed BAL rating of 12.5 needs to be used with caution and considered to be the minimum appropriate value.

At the lighthouse, the main risk is to the lantern windows (as was the case during the 1994 fire). The tower itself is relatively fire resistant (although fire could cause cracking of the tower's render). The tower's door and lower windows are likely to be damaged in a fire but should be easy to repair. The lantern windows in the lighthouse tower are about 4 millimetres thick and the glass is unlikely to be toughened (note that prior to the 1995 fire, the lighthouse windows were greater than five millimetres thick). This means the lighthouse has an effective BAL rating of 12.5.

The most likely fire spread direction at the lighthouse is from the north, followed by the east and west. Fires are less likely to impact the lighthouse from the south

(although it appears that the 1972 fire did impact from the southwest and burnt the lighthouse generator shed[47]).

The current distances from the lighthouse to unmanaged vegetation, the slope of surrounding unmanaged vegetation and the corresponding setbacks required for a BAL rating of 12.5 are in Table 18. There is also considerable vegetation regrowth occurring adjacent to the lighthouse which needs to be cleared.

This means that in order to reduce the lighthouse BAL ratings to 12.5, the cleared area surrounding the lighthouse needs to be cleared and expanded by 10 to 25 m (depending on the direction).

Table 18. BAL factors at the lighthouse.

Direction of fire spread	Fire likelihood	Slope	Current distance to unmanaged vegetation	Current BAL	Distance required to meet BAL 12.5
N	high	22°	42 m	29	>67 m
S	low	8°	36 m	29	>46 m
E	medium	15°	31 m	19	>56 m
W	medium	12°	38 m	19	>46 m

4.9.2 Bushfire risk assessment

This bushfire risk assessment has been performed for two scenarios:

1 current situation of no active bushfire risk mitigation, and;
2 bushfire risk mitigation by reducing ignition risk and performing weather monitoring.

In order to perform the second scenario, the following actions were assumed:

- wood fired BBQ at East Cove is removed;
- comprehensive briefing of caretakers regarding bushfire risk at their induction;
- active monitoring of weather by PWS staff and caretaker notification when the level of fire danger is forecast to exceed specific thresholds;
- cessation of the use of the ATV and mowing during periods of elevated fire danger;
- erection of bushfire risk warning signs during periods of elevated fire danger, and;
- closure of the reserve when the level of fire danger exceeds a specific threshold.

Due to its location at the base of the slope at East Cove on the compounds northwest boundary, the wood fired BBQ is probably the single highest bushfire risk factor that can be easily managed. This could be done by removing the BBQ.

At the current time, fire danger predictions are not made by the BoM for Deal Island. However, using the BoM MetEye forecasts PWS staff could easily make such predictions using Deal Island specific weather inputs, with these forecasts having adequate reliability up to at least four days in advance.

When forecast weather data is obtained from MetEye, it is recommended that the data for 39.50°S 147.34°E be used (approximates the location of Squally Bay).

When these fire danger predictions are made, it is recommended that the Project Vesta fire model[48] is used for the fire spread rate in the McArthur fire danger rating model[49] (see Box 3).

[47] Australian Marine and Safety Authority records in Deal Island caretakers house.

[48] Cheney NP, Gould JS, McCaw WL and Anderson WR 2012. Predicting fire behaviour in dry eucalypt forest in southern Australia. Forest Ecology and Management 280: 120-131.

[49] McArthur AG 1967. Fire behaviour in eucalypt forest. Leaflet 107, Forestry and Timber Bureau, Department of National Development, Commonwealth of Australia, Canberra, Australian Capital Territory.

When the fire danger is predicted to equal or exceed a Forest Fire Danger Rating (FFDR) of 24 the caretakers could erect warning signs at East Cove and check the Winter Cove campsite for kayakers. When the FFDR is predicted to equal or exceed a FFDR of 38 the caretakers could erect warning signs stating that the reserve is closed until the level of fire danger moderates. These signs could be pre-prepared with pre-installed posts so they are ready for easy deployment.

When elevated fire danger is forecast, if the caretakers need to use the ATV to access Winter Cove or the lighthouse, they should only do so prior to 11:00 in the morning, with no further use of the ATV or mowers until the fire danger moderates.

If planned burning was performed in the open grasslands adjacent to the compound, the reduction in the level of fuel hazard would further decrease the level of fire risk.

Using the system outlined in the TERAG, the categories detailed in Table 19 have been determined.

At the current time, the bushfire risk to people and cultural assets has been rated as extreme and the bushfire risk to environmental values as medium (Table 19).

However, if the bushfire risk mitigation factors outlined above are implemented, the level of bushfire risk to people and cultural assets should be reduced to medium and the level of bushfire risk to environmental values to low (Table 19).

Regardless of what bushfire risk mitigation actions are performed, it is important that the grass in the outer and inner compound areas is kept well mowed.

These areas provide for a very low fuel zone surrounding the houses. It needs to be noted that under dry conditions and high levels of fire danger, a bushfire will have a high probability of sustaining across the compound's mowed areas (as appears to have occurred in the compound during the 1972 fire). However, if it did this, it would burn as a very low intensity fire which is unlikely to be a high threat to human life. Such a bushfire could conceivably be of sufficient intensity to ignite the compound houses, but if it did this it would take some time to do so allowing for the houses to form an effective refuge during the passage of fire front.

Because of the risk of fires impacting on the compound and since it cannot be assumed that the island's caretakers are experienced in managing fire, it is recommended that the compound be kept at its current size.

If it was decided that additional fire protection was required, then sprinklers could easily be fitted to the caretaker's house, which should provide for protection under all likely levels of fire danger.

Full moon from the lighthouse

Table 19. Bushfire risk assessment categories.

TERAG table	Category	Assessed level	Reason
Risk assessment inputs			
11	control strength	medium	controls used are effective.
11	control expediency	medium	controls may be infrequently applied but their use is foreseen, well understood and have been planned for.
15	control impact	unlikely	controls have a high probability of being effective.
17	confidence in risk assessment	high	
1. Current situation of no active bushfire risk mitigation			
12	control effectiveness	low	
13	consequence: people	major	potential for significant injuries and/or deaths.
13	consequence: environment	minor	species are adapted to fire and are long unburnt.
13	consequence: cultural	major	potential to burn lighthouse buildings.
14	likelihood	likely	bushfires are likely to occur at least once per decade.
15	control impact	likely	controls have a high probability of being effective.
16	risk to people and cultural assets	extreme	
	risk to environmental values	medium	
2. bushfire risk mitigation by reducing ignition risk and weather monitoring			
12	control effectiveness if applied	medium	
13	consequence: people	moderate	potential for significant injuries and/or deaths.
13	consequence: environment	minor	species are adapted to fire and are long unburnt.
13	consequence: cultural	moderate	potential to burn lighthouse buildings.
14	likelihood	likely	bushfires are likely to occur at least once per decade.
15	control impact	unlikely	controls have a high probability of being effective.
16	risk to people and cultural assets	medium	
	risk to environmental values	low	

Looking southwest from Middle Hill

4.10. Wildlife observations and monitoring

4.10.1 Camera trapping

There have been reports from a previous caretaker of a small macropod which was seen at Winter Cove. In February 2022, a similar report was received from a kayaker camping near the same location who had a small macropod hopping around their tent at night. The animal's size was reported to be about 20 cm long (excluding tail).

The species seen is uncertain but could potentially be a White-footed dunnart which has been observed on nearby North East Isle[50]. Alternatively, the species could be a young wallaby joey, similar to one seen by JMS at last light one evening on the road to East Cove.

During the period between December 2021 and February 2022 two motion detection cameras were set up at a number of sites on Deal Island (Table 20). The cameras had a bait station containing peanut butter and rolled oats to attract the animals.

The motion detection cameras captured images of wallabies, possums, Cape Barron geese, penguins, house mice and lots of brown rats (Figure 30).

Table 20. Deal Island camera trap locations.

Camera and location		Dates	Habitat	Easting	Northing
BG8	Garden Cove	01-15/12/21	sand dune vegetation	527949	5632305
BG26	Garden Cove	01-15/12/21	sand dune vegetation	527963	5632287
BG8	Little Squally Cove	16-31/12/21	*Poa* grassland next to creek	526990	5629979
BG26	Little Squally Cove	16-31/12/21	*Poa* grassland next to creek	527012	5629984
BG8	Old Squally track	02-19/01/22	eucalypt mallee low dry forest	527741	5629621
BG26	Old Squally track	02-19/01/22	eucalypt mallee low dry forest	527739	5629615
BG8	Winter Cove	21/01/22-07/02/22	she-oak woodland next to creek	529546	5630808
BG26	Winter Cove	21/01/22-07/02/22	she-oak woodland next to creek	529593	5630808
BG8	Lighthouse road	08-17/02/22	she-oak closed forest	527501	5630021
BG26	Lighthouse road	08-17/02/22	she-oak closed forest	527511	5630028
BG8	Winter Cove track	17-??/02/22	Poa grassland	527195	5630581
BG26	Winter Cove track	17-??/02/22	Poa grassland	527204	5630582

Camera trap set up in she-oak closed forest

[50] Brothers N, Pemberton D, Pryor H and Halley V 2001. Tasmania's offshore islands: seabirds and other natural features. Tasmanian Museum and Art gallery, Tasmania.


a) Brush-tail possum


b) Bennetts wallaby


c) Little penguin


d) Ground thrush


e) Brown rat


f) House mouse

Figure 30. Camera trap photographs.

4.10.2 Other wildlife

The sea eagle nest near Pulpit Rock is in active use with two well developed chicks seen in December 2021 and January 2022 (Figure 31a). The nest had also been added to over the past six years and is now over two metres tall (Figure 31b and c).

During our caretaker period we frequently saw peregrine falcons (both male and female) hunting around the cliffs above Little Squally Cove and East Cove. We also saw Nankeen kestrels, brown falcons and swamp harriers (Figure 32).

At each of Garden Cove, East Cove, Winter Cove, Pegleg Bay, Little Squally Cove and Squally Cove we saw a pair of sooty oystercatchers, some of which had chicks. No pied oystercatchers or hooded plovers were seen.

Early in our period we had three Cape Barron geese families in the compound, two with three chicks and one with two chicks. Each family had their own territory based around its own water bath. By late January the chicks had grown up and the parents were doing tough love and kicking the young out (Figure 32c and d).

a) Sea eagle fledglings in January 2022

b) Nest in February 2016

c) Nest in December 2021

Figure 31. Pulpit Rock sea eagle nest.

a) flame robin

b) Nankeen kestrel

c) goslings taking a bath

d) show-down at the water trough - possum vs geese

Figure 32. Other wildlife photographed on Deal Island.

4.11 Other activities undertaken during our caretaker period

During our period on Deal Island we did bushwalks across most of the island and did lots of swimming.

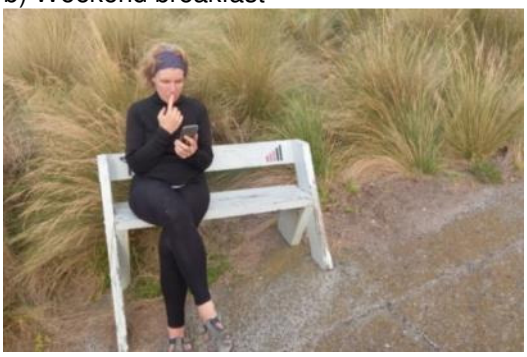
When we first got to Deal Island the water was still cold when snorkelling. However, by mid-December it had warmed up enough to leave our wetsuits behind.

A selection of photos is in Figure 33.

a) Xmas Day lunch

b) Weekend breakfast

c) Driving the ATV



d) Keeping in touch

e) In head-high scrub

f) Bushwalking down the western ridgeline from the island's highpoint

Figure 33. Other activities.

5 References

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View from the lighthouse looking north

Appendix 1. Information lodged with the PWS

A1.1 Background data

- access;
- points of interest: cairns, graves and memorials;
- drainage, contours and coastlines;
- weather data downloaded from BoM website.

A1.2 Map data

- aerial photographs and satellite images:
  - 06/02/1982 black and white aerial photograph;
  - 27/11/1986 colour aerial photograph;
  - 16/02/2000 colour aerial photograph;
  - 04/09/2007 colour aerial photograph;
  - 9/07/2010 Spot satellite;
  - 29/03/2012 colour aerial photograph;
  - 30/09/2016 Google Earth;
  - 12/11/2020 ListMap ESRI satellite.
- vegetation distribution in 1995;
- vegetation distribution in 2000;
- vegetation change on Deal and Erith Islands;
- fire history on Deal Island;
- weed mapping: ragwort, sea spurge, arum lily, great mullein and horehound;
- all output maps in pdf format.

A1.3 Field data

- vegetation and fuel field data;
- photographs of all vegetation and fuel sites, points of interest;
- weed data:
  - FODI weed raw data;
  - weed data collected by JMS in November 2015 and February 2016;
  - weed data collected by JMS and GW between December 2021 and February 2022.

A few areas of eucalypt dry forest had dense understories and extreme levels of fuel hazard

Appendix 2. Fuel and vegetation raw data

Appendix 2a. Fuel raw data

				Surface			Near-surface					Elevated					Bark		O	Fuel
Id	Grid reference Easting	Northing	Vegetation type	cvr %	hgt cm	F	cvr %	hgt cm	dd %	C	F	cvr %	hgt m	dd %	C	F	T	F	F	load t/ha
1	527516	5631231	Poa grassland	60	5	VH	85	70	60	VH	E								E	15
2	527496	5631338	She-oak open Df	70	5	VH	75	70	60	VH	E	20	3	10	L	L	O	L	H	15
3	527595	5631644	Melaleuca Ws	90	3	VH	50	45	95	H	VH	70	3	30	VH	E	O	M	E	12
4	527687	5631771	She-oak closed Df	90	5	VH	40	30	90	H	VH	15	1.5	95	L	M	O	L	H	10
5	527735	5629604	Eucalypt mallee Df	95	3	VH	20	50	40	L	M	10	1.75	10	L	L	C	L	H	10
6	527819	5629541	Eucalypt mallee Df	95	6	E	70	50	90	H	E	65	2.5	30	H	E	C	VH	E	12
7	528188	5629575	She-oak, tea-tree Ds	70	3	H	50	60	70	M	H	60	2	20	H	VH	C	L	VH	8
8	528059	5628935	Eucalypt mallee Df	75	5	VH	25	40	75	M	H	20	1.25	20	M	M	C	VH	E	12
9	528335	5628900	Eucalypt Df	95	5	VH	20	50	30	M	M	25	2	10	M	M	C	VH	E	15
10	527557	5629949	She-oak closed Df	70	3	H	30	40	95	M	H	10	2.5	15	L	L	O	L	H	8
11	527448	5630250	Poa grassland	25	3	M	95	60	40	VH	E								E	15
12	527884	5630853	She-oak closed Df	90	3	H	15	35	100	M	M	25	2.5	100	M	H	O	L	VH	10
13	528456	5631083	She-oak Dd	40	3	M	80	60	40	VH	E	1	2	10	VL	VL	O	L	H	15
14	529555	5631930	Eucalypt mallee Df	80	3	VH	30	30	50	M	M	1	1.5	100	L	L	C	L	H	8
15	529451	5631721	She-oak open Df	40	2	L	30	25	30	M	M						O	L	L	6
16	527811	5628249	Eucalypt Ds	60	5	H	50	30	40	H	H	40	2	15	H	VH	C	M	VH	10
17	528563	5631305	Eucalypt mallee Df	60	3	H	25	75	50	M	M	20	3	25	M	M	C	H	H	10
18	528400	5631288	She-oak closed Df	90	2	H	30	50	95	M	H	1	2.5	10	L	L	O	L	H	10
19	528187	5631276	Poa grassland	40	5	H	80	60	50	VH	E	0.5	3	10	VL	VL	O	VL	E	20
20	527714	5631587	Melaleuca Ws	70	10	VH	30	50	100	M	H	1	3	15	L	L	O	VH	E	12
21	527545	5628463	Eucalypt Ds	80	5	VH	30	25	60	M	H	40	2	25	H	H	C	L	VH	15
22	527480	5628638	Eucalypt Ds	30	5	M	50	125	20	VH	VH	5	2.5	15	L	L	C	L	H	8
23	526288	5630415	She-oak closed Df	70	3	H	25	30	100	M	M	10	1.5	100	L	L	O	L	H	10
24	529294	5631937	She-oak closed Df	75	5	H	20	40	100	M	M	5	2.5	10	L	L	O	L	H	12
25	528806	5632744	Eucalypt Ds	20	3	L	80	150	25	VH	E	15	3	15	M	M	C	L	H	15
26	527571	5630023	She-oak closed Df	80	5	H	40	25	95	M	H	1	3	10	L	L	O	L	H	8
27	528345	5629470	Eucalypt Df	90	5	VH	30	40	60	H	VH	15	1.75	20	M	M	C	M	H	15
28	528538	5629528	Melaleuca-teatree Ws	25	1	L	20	20	95	L	L	80	3	25	E	E	O	M	E	20
29	528619	5629486	Eucalypt Df	90	5	VH	70	60	90	VH	E	60	5	30	VH	E	C	H	E	25
30	528772	5629894	Eucalypt Df	95	10	E	50	60	100	VH	E	15	3	20	M	M	C	H	H	30
31	528823	5630109	Eucalypt Df	90	10	E	30	60	40	M	VH	5	2	10	L	L	C	H	H	15
32	527901	5628171	She-oak, tea-tree Ds	30	2	M	40	60	30	M	M	40	2	25	H	VH	O	L	VH	6
33	527092	5630119	Sedgy grassland	60	10	VH	80	120	40	VH	E	0.5	3	20	VL	VL	O	VL	H	20
34	527226	5630615	She-oak Dd	40	5	M	50	35	60	M	M	10	3	20	M	M	O	L	M	8
35	527123	5630725	She-oak Dd	50	5	M	60	40	50	H	H	10	2.5	25	M	M	O	L	M	10

View from Barn Hill looking south over Little Squally Cove

Appendix 2b. Vegetation raw data

		Overstorey			Understorey			Ground	Photos
Id	Vegetation type	species	cvr %	hgt m	species	cvr %	hgt m		Photos
1	Poa grassland	Poa	95	1				litter	263
2	She-oak open Df	Allo vert	30	6	Acca vert	10	3	Poa	264
3	Melaleuca wet scrub	Allo vert	40	6	Mela eric	70	3	litter	265
4	She-oak closed Df	Allo vert	60	8				litter	266
5	Eucalypt mallee Df	Euca niti	40	5	Kunz ambi Acca murc	15	2	litter	269-70
6	Eucalypt mallee Df	Euca niti	30	5	Lept scop Acca murc Kunz ambi	70	4	litter	271-72
7	She-oak tea-tree DS	Allo vert Euca niti	10	4	Kunz ambi Lept scop	70	2	litter	273-74
8	Eucalypt mallee Df	Euca niti	35	5	Acca mucr	20	1.5	litter	278-79
9	Eucalypt Df	Euca niti	40	10	Phab squm	20	2.5	litter	280-81
10	She-oak closed Df	Allo vert	50	8				litter	282-83
11	Poa grassland	Poa	95	0.6				litter	284-85
12	She-oak closed Df	Allo vert	60	8				litter	286-87
13	She-oak dry WD	Allo vert	15	8	Allo vert	10	4	Poa	290-91
14	Eucalypt mallee Df	Euca niti	40	7				litter	292-93
15	She-oak open Df	Allo vert	35	8	Poa	30	0.3	litter	299-300
16	Eucalypt DS	Euca niti	40	4	Kunz ambi Allo vert Lept spp Clit rhum	30	2	Lepi elat	312
17	Eucalypt mallee Df	Euca niti	40	10	Acca vert Acca mucr Allo vert	20	4	litter	343-44
18	She-oak closed Df	Allo vert	50	8	Kunz ambi Acca mucr	50	3	litter	345-46
19	Poa grassland	Poa	75	0.6	Ptyr esci	30	1	litter	347-48
20	Melaleuca wet scrub	Mela eric	70	10				litter	350-51
21	Eucalypt DS	Euca niti	40	4	Accr mucr Lept lavi Pult daph	40	2	litter	380-81
22	Eucalypt DS	Euca niti	10	2.5	Lept lavi Euca niti Mono glav Pult daph	50	1.5	litter	382-83
23	She-oak closed Df	Allo vert	70	8	Allo vert (dead)			litter	415-16
24	She-oak closed Df	Allo vert	50	8	Kunz ambi	5	2.5	litter	417-18
25	Eucalypt DS	Euca niti	15	3	Lept lavi Lept scop Accr mucr	80	2	litter	432-433
26	She-oak closed Df	Allo vert	60	12				litter	452-53
27	Eucalypt Df	Euca niti	50	10	Kunz ambi Acca murc Mela eric	15	3	bracken litter	454-55
28	Melaleuca-tea tree Ws	Mela eric Lept scop	80	3				litter	456-57
29	Eucalypt Df	Euca niti	40	15	Clit rhum	60	5	litter	458-59
30	Eucalypt Df	Euca niti	50	20	Clit rhum	40	8	litter	460-61
31	Eucalypt Df	Euca niti	40	30	Mela eric Phab squm	5	3	bracken litter	
32	She-oak tea-tree DS	Allo vert	30	3	Lept scop Kunz ambi	20	2	litter	484-87
33	Sedgy grassland	Lepy elat	60	1	Poa	50	0.75	litter	488-90
34	She-oak dry WD	Allo vert	15	4	Allo vert	10	2	Poa	493-94
35	She-oak dry WD	Allo vert	10	3	Poa Allo vert	50	0.5	Poa	495-96

Note: species names use the 4-4 abbreviation ie Allo vert = *Allocasuarina verticillata* (she-oak); cvr = foliage projective cover.

Bennetts wallaby feeding on a fallen she-oak

Appendix 3. Point location weed data

Appendix 3a. Previously recorded point location weed data

Note: Patches of ragwort have been mapped separately as polygons.

Id	Weed	Site	Status	Date	Easting	Northing
1	Agapanthus	OW038			527077	5630382
2	Agapanthus	AP020	Active		527675	5628369
3	Agapanthus	AP019	Active		527682	5628349
4	Agapanthus	AP1	Active		527682	5628349
5	Agapanthus	AP018	Active		527709	5628344
6	Agapanthus	AP2	Active		527709	5628345
7	Arum Lily	AL035			526604	5630516
8	Arum Lily	AL135			526638	5630495
9	Arum Lily	AL089			526642	5630441
10	Arum Lily	AL087			526642	5630497
11	Arum Lily	AL136			526644	5630442
12	Arum Lily	AL127			526671	5630470
13	Arum Lily	AL086			526685	5630436
14	Arum Lily	AL036			526690	5630477
15	Arum Lily	AL155			526722	5631193
16	Arum Lily	AL084			526770	5630375
17	Arum Lily	AL029			526794	5630373
18	Arum Lily	AL154			526799	5631040
19	Arum Lily	AL098			526800	5630366
20	Arum Lily	AL040			526802	5631009
21	Arum Lily	AL128			526805	5630367
22	Arum Lily	AL090			526810	5630431
23	Arum Lily	AL030			526824	5630416
24	Arum Lily	AL032			526873	5630506
25	Arum Lily	AL037		12/05/2021	526897	5630722
26	Arum Lily	AL092			526911	5630440
27	Arum Lily	AL172			526912	5630812
28	Arum Lily	AL131			526914	5630437
29	Arum Lily	AL173			526920	5630815
30	Arum Lily	AL026			526924	5630451
31	Arum Lily	AL1	Active		526927	5630734
32	Arum Lily	AL093			526935	5630451
33	Arum Lily	AL094			526938	5630476
34	Arum Lily	AL132			526939	5630447
35	Arum Lily	AL133			526942	5630473
36	Arum Lily	AL052		12/05/2021	526944	5630725
37	Arum Lily	AL116			526944	5630837
38	Arum Lily	AL023			526945	5630454
39	Arum Lily	AL024			526946	5630476
40	Arum Lily	AL022			526950	5630448
41	Arum Lily	AL104		12/05/2021	526954	5630688
42	Arum Lily	AL2	Active		526955	5630756
43	Arum Lily	AL168		12/05/2021	526962	5630736
44	Arum Lily	AL188			526967	5630771
45	Arum Lily	AL016		12/05/2021	526970	5630735
46	Arum Lily	AL095		12/05/2021	526975	5630476
47	Arum Lily	AL043			526976	5630817
48	Arum Lily	AL134		12/05/2021	526979	5630472
49	Arum Lily	AL046			526982	5630385
50	Arum Lily	AL105		12/05/2021	526982	5630697
51	Arum Lily	AL166		12/05/2021	526983	5630752
52	Arum Lily	AL144		12/05/2021	526984	5630694
53	Arum Lily	AL038		12/05/2021	526986	5630741
54	Arum Lily	AL103		12/05/2021	526995	5630660
55	Arum Lily	AL165		12/05/2021	526997	5630769
56	Arum Lily	AL147		12/05/2021	526998	5630656
57	Arum Lily	AL3	Active		526998	5630765
58	Arum Lily	AL081		12/05/2021	527000	5630739
59	Arum Lily	AL164		12/05/2021	527000	5630768
60	Arum Lily	AL159		12/05/2021	527002	5630495
61	Arum Lily	AL112		12/05/2021	527006	5630750

Id	Weed	Site	Status	Date	Easting	Northing
62	Arum Lily	AL163		12/05/2021	527008	5630764
63	Arum Lily	AL4	Active		527009	5630732
64	Arum Lily	AL096		12/05/2021	527011	5630514
65	Arum Lily	AL162		12/05/2021	527021	5630766
66	Arum Lily	AL5	Active		527022	5630721
67	Arum Lily	AL106		15/05/2021	527023	5630704
68	Arum Lily	AL102		15/05/2021	527024	5630642
69	Arum Lily	AL145		15/05/2021	527025	5630701
70	Arum Lily	AL151		14/05/2021	527027	5630636
71	Arum Lily	AL6	Active		527034	5630736
72	Arum Lily	AL047		15/05/2021	527040	5630627
73	Arum Lily	AL051		23/01/2018	527043	5630516
74	Arum Lily	AL185		15/05/2021	527046	5630602
75	Arum Lily	AL7	Active		527051	5630705
76	Arum Lily	AL048		15/05/2021	527052	5630595
77	Arum Lily	AL107		15/05/2021	527052	5630688
78	Arum Lily	AL8	Active		527055	5630550
79	Arum Lily	AL9	Active		527056	5630698
80	Arum Lily	AL187		15/05/2021	527057	5630667
81	Arum Lily	AL140		15/05/2021	527058	5630540
82	Arum Lily	AL083		15/05/2021	527066	5630674
83	Arum Lily	AL044		13/05/2021	527071	5630795
84	Arum Lily	AL050		15/05/2021	527074	5630538
85	Arum Lily	AL053		15/05/2021	527074	5630652
86	Arum Lily	AL054			527081	5630395
87	Arum Lily	AL10	Active		527096	5630681
88	Arum Lily	AL100		15/05/2021	527108	5630541
89	Arum Lily	AL011		15/05/2021	527108	5630682
90	Arum Lily	AL139		13/05/2021	527110	5630535
91	Arum Lily	AL108		15/05/2021	527111	5630669
92	Arum Lily	AL099		15/05/2021	527115	5630516
93	Arum Lily	AL021			527119	5630632
94	Arum Lily	AL010			527154	5630722
95	Arum Lily	AL015			527182	5630662
96	Arum Lily	AL012			527186	5630741
97	Arum Lily	AL192			527200	5630461
98	Arum Lily	AL152			527204	5630646
99	Arum Lily	AL194			527207	5630864
100	Arum Lily	AL013			527208	5630773
101	Arum Lily	AL153			527213	5630703
102	Arum Lily	AL014			527224	5630779
103	Arum Lily	AL017			527230	5630711
104	Arum Lily	AL045			527233	5630808
105	Arum Lily	AL101			527237	5630510
106	Arum Lily	AL019			527248	5630732
107	Arum Lily	AL055			527250	5630498
108	Arum Lily	AL020			527301	5630760
109	Arum Lily	AL161			527312	5630865
110	Arum Lily	AL11	Active		527316	5630710
111	Arum Lily	AL195			527325	5630539
112	Arum Lily	AL077			527359	5630720
113	Arum Lily	AL118		15/05/2021	527415	5630763
114	Arum Lily	AL12	Active		527427	5630742
115	Arum Lily	AL13	Active		527523	5630766
116	Arum Lily	AL006		14/05/2021	527652	5629137
117	Arum Lily	AL003		14/05/2021	527655	5628334
118	Arum Lily	AL001		14/05/2021	527661	5628388
119	Arum Lily	AL008			527672	5631792
120	Arum Lily	AL007		14/05/2021	527696	5629144
121	Arum Lily	AL14	Active		527704	5629211
122	Arum Lily	AL126		14/05/2021	527705	5629185
123	Arum Lily	AL002		14/05/2021	527709	5628391
124	Arum Lily	AL121		14/05/2021	527715	5629170
125	Arum Lily	AL005		14/05/2021	527719	5629248
126	Arum Lily	AL125		14/05/2021	527720	5629189

Id	Weed	Site	Status	Date	Easting	Northing
127	Arum Lily	AL122		14/05/2021	527723	5629163
128	Arum Lily	AL158		14/05/2021	527736	5629274
129	Arum Lily	AL009		14/05/2021	527736	5629317
130	Arum Lily	AL004		14/05/2021	527747	5629287
131	Creticum Mullein	OW046			527328	5630667
132	Creticum Mullein	CM1	Active		527720	5631571
133	Creticum Mullein	OW035			527806	5631964
134	Creticum Mullein	OW040			527808	5632013
135	Creticum Mullein	OW041			527912	5632011
136	Creticum Mullein	OW030			527940	5632059
137	Creticum Mullein	OW001		10/02/2018	528221	5632291
138	Creticum Mullein	CM2	Active		528402	5631173
139	Creticum Mullein	OW039			528488	5631185
140	Creticum Mullein	OW045			528520	5631162
141	Creticum Mullein	OW037			529395	5630854
142	Creticum Mullein	OW036			529403	5630870
143	Great Mullein	GM1	Active		527061	5630701
144	Great Mullein	GM2	Active		527236	5630793
145	Great Mullein	GM3	Active		527245	5630811
146	Great Mullein	GM4	Active		527265	5630835
147	Great Mullein	GM5	Active		527274	5630850
148	Great Mullein	GM6	Active		527287	5630831
149	Great Mullein	GM7	Active		527311	5630826
150	Great Mullein	GM8	Active		527313	5630850
151	Great Mullein	GM9	Active		527322	5630834
152	Great Mullein	GM10	Active		527322	5630852
153	Great Mullein	GM11	Active		527336	5630889
154	Great Mullein	GM12	Active		527368	5630967
155	Great Mullein	GM13	Active		527381	5630862
156	Great Mullein	GM14	Active		527432	5630734
157	Great Mullein	GM052	Active		527560	5630686
158	Great Mullein	GM15	Active		527928	5632081
159	Great Mullein	OW002			527996	5632126
160	Great Mullein	GM042	Active		528009	5632116
161	Great Mullein	GM16	Active		528010	5632116
162	Great Mullein	GM17	Active		529421	5630898
163	Great Mullein	GM06	Active		529422	5630869
164	Horehound	HH043			526284	5630411
165	Horehound	HH013			526512	5630526
166	Horehound	HH060	Active		526521	5630457
167	Horehound	HH015			526587	5630527
168	Horehound	HH002			527799	5632063
169	Horehound	HH039			527969	5632147
170	Horehound	HH005			528022	5632191
171	Horehound	HH014			528039	5632212
172	Horehound	HH037			528048	5632207
173	Horehound	HH019			528062	5632251
174	Horehound	HH020			528091	5632260
175	Horehound	HH004			528095	5632196
176	Horehound	HH041		10/05/2021	528097	5632308
177	Horehound	HH021			528157	5632262
178	Horehound	HH022			528175	5632267
179	Horehound	HH006			528194	5632265
180	Horehound	HH007			528195	5632286
181	Horehound	HH003			528239	5632327
182	Marram grass	MG1	Active		527906	5632395
183	Marvel of Peru	OW042			527853	5632005
184	Ragwort	RW109			526907	5630154
185	Ragwort	RW065			526968	5629962
186	Ragwort	RW114			526974	5630121
187	Ragwort	RW101			527028	5630035
188	Ragwort	RW092			527033	5630204
189	Ragwort	RW087		12/05/2021	527041	5630706
190	Ragwort	RW104			527052	5630823
191	Ragwort	RW2	Active		527061	5630705

Id	Weed	Site	Status	Date	Easting	Northing
192	Ragwort	RW111			527061	5630816
193	Ragwort	RW053			527076	5630585
194	Ragwort	RW078	Active		527080	5630594
195	Ragwort	RW3	Active		527081	5630595
196	Ragwort	RW054			527104	5630663
197	Ragwort	RW112			527108	5630847
198	Ragwort	Rw090			527115	5630789
199	Ragwort	RW115			527130	5630378
200	Ragwort	RW077			527151	5630806
201	Ragwort	RW121			527207	5630584
202	Ragwort	RW093			527219	5630968
203	Ragwort	RW089			527244	5630371
204	Ragwort	RW094			527246	5631001
205	Ragwort	RW126			527293	5630245
206	Ragwort	RW108			527302	5630964
207	Ragwort	RW095			527302	5631058
208	Ragwort	RW120			527305	5630975
209	Ragwort	RW097			527322	5631086
210	Ragwort	RW107			527328	5630244
211	Ragwort	RW096			527329	5631091
212	Ragwort	RW092	Active		527377	5632176
213	Ragwort	RW5	Active		527378	5632176
214	Ragwort	RW098			527416	5631181
215	Ragwort	RW123			527637	5630751
216	Ragwort	RW051			527663	5630781
217	Ragwort	RW055			527684	5632297
218	Ragwort	RW028	Active		527698	5632168
219	Ragwort	RW6	Active		527698	5632168
220	Ragwort	RW066			527703	5631588
221	Ragwort	RW099			527721	5631532
222	Ragwort	RW050			527722	5630508
223	Ragwort	RW039	Active		527815	5631959
224	Ragwort	RW7	Active		527815	5631959
225	Ragwort	RW075			527818	5632068
226	Ragwort	RW064			527854	5632222
227	Ragwort	RW052			527895	5630766
228	Ragwort	RW070			527919	5630745
229	Ragwort	RW068			527922	5631986
230	Ragwort	RW071			527923	5630753
231	Ragwort	RW069			527946	5630681
232	Ragwort	RW8	Active		527946	5632008
233	Ragwort	RW081			527965	5632186
234	Ragwort	RW075			527981	5632013
235	Ragwort	RW067			528036	5631990
236	Ragwort	RW037	Active		528060	5631328
237	Ragwort	RW9	Active		528060	5631328
238	Ragwort	RW083			528158	5630943
239	Ragwort	RW102			528172	5631022
240	Ragwort	RW128			528186	5631007
241	Ragwort	RW127			528200	5630901
242	Ragwort	RW072			528231	5631070
243	Ragwort	RW125			528255	5631256
244	Ragwort	RW100			528289	5631248
245	Ragwort	RW049			528326	5631240
246	Ragwort	RW048			528355	5631236
247	Ragwort	RW103			528427	5631225
248	Ragwort	RW124			528487	5631192
249	Ragwort	RW113			528498	5631221
250	Ragwort	RW078			528599	5631202
251	Ragwort	RW116			528626	5631207
252	Ragwort	RW057			528638	5631139
253	Ragwort	RW058			528727	5631163
254	Ragwort	RW110			528783	5631158
255	Ragwort	RW059			528818	5631147
256	Ragwort	RW073			529047	5630532

Id	Weed	Site	Status	Date	Easting	Northing
257	Ragwort	RW074			529077	5630724
258	Ragwort	RW060			529111	5630945
259	Ragwort	RW003			529112	5631322
260	Ragwort	RW007			529142	5631175
261	Ragwort	RW008			529142	5631292
262	Ragwort	RW001			529142	5631310
263	Ragwort	RW006			529150	5631182
264	Ragwort	RW047			529162	5631366
265	Ragwort	RW005			529163	5631188
266	Ragwort	RW030			529164	5631666
267	Ragwort	RW009			529168	5631311
268	Ragwort	RW046			529168	5631374
269	Ragwort	RW004			529180	5631186
270	Ragwort	RW010			529181	5631323
271	Ragwort	RW029			529181	5631666
272	Ragwort	RW021			529186	5631343
273	Ragwort	RW044			529186	5631382
274	Ragwort	RW028			529186	5631661
275	Ragwort	RW061			529188	5630937
276	Ragwort	RW027			529192	5631664
277	Ragwort	RW080			529194	5631272
278	Ragwort	RW011			529197	5631345
279	Ragwort	RW043			529202	5631377
280	Ragwort	RW019			529215	5631473
281	Ragwort	RW041			529225	5631372
282	Ragwort	RW022			529230	5631402
283	Ragwort	RW018			529232	5631523
284	Ragwort	RW026			529232	5631652
285	Ragwort	RW037			529243	5631140
286	Ragwort	RW013			529253	5631458
287	Ragwort	RW035			529262	5631155
288	Ragwort	RW017			529264	5631597
289	Ragwort	RW036			529265	5631134
290	Ragwort	RW014			529269	5631500
291	Ragwort	RW024			529271	5631648
292	Ragwort	RW034			529273	5631139
293	Ragwort	RW023			529277	5631648
294	Ragwort	RW033			529278	5631143
295	Ragwort	RW016			529288	5631624
296	Ragwort	RW032			529293	5631151
297	Ragwort	RW079			529302	5631552
298	Ragwort	RW015			529308	5631632
299	Ragwort	RW130			529361	5631010
300	Ragwort	RW040			529368	5631326
301	Ragwort	RW129			529395	5630854
302	Ragwort	RW039			529402	5631348
303	Ragwort	RW038			529427	5631373
304	Ragwort	RW062			529615	5630892
305	Ragwort	RW106			529945	5631315
306	Sea spurge	SS085	Active		524481	5633621
307	Sea spurge	SS1	Active		524481	5633621
308	Sea spurge	SS086	Active		524512	5633624
309	Sea spurge	SS2	Active		524513	5633624
310	Sea Spurge	SS062		15/05/2021	526739	5630518
311	Sea spurge	SS059	Active		526776	5630477
312	Sea spurge	SS058	Active		526803	5630492
313	Sea Spurge	SS060			526803	5630535
314	Sea spurge	SS013	Active		526833	5630508
315	Sea spurge	SS056	Active		526921	5630585
316	Sea spurge	SS012	Active		526929	5630599
317	Sea spurge	SS057	Active		526941	5630653
318	Sea Spurge	SS026			527311	5630915
319	Sea spurge	SS3	Active		527675	5632277
320	Sea spurge	SS4	Active		527685	5632401
321	Sea spurge	SS5	Active		527697	5632209

Id	Weed	Site	Status	Date	Easting	Northing
322	Sea spurge	SS6	Active		527697	5632387
323	Sea spurge	SS7	Active		527700	5632407
324	Sea spurge	SS8	Active		527703	5632385
325	Sea spurge	SS027	Active		527709	5632216
326	Sea spurge	SS9	Active		527709	5632217
327	Sea spurge	SS026	Active		527712	5632389
328	Sea spurge	SS10	Active		527712	5632390
329	Sea spurge	SS11	Active		527719	5632089
330	Sea spurge	SS12	Active		527727	5632271
331	Sea spurge	SS13	Active		527736	5632128
332	Sea spurge	SS14	Active		527751	5632234
333	Sea spurge	SS15	Active		527751	5632352
334	Sea spurge	SS16	Active		527758	5632113
335	Sea spurge	SS17	Active		527763	5632158
336	Sea spurge	SS18	Active		527772	5632350
337	Sea spurge	SS19	Active		527775	5632424
338	Sea spurge	SS20	Active		527776	5632173
339	Sea Spurge	SS022			527777	5631958
340	Sea spurge	SS21	Active		527777	5632348
341	Sea spurge	SS22	Active		527784	5632212
342	Sea spurge	SS025	Active		527784	5632409
343	Sea spurge	SS23	Active		527784	5632409
344	Sea spurge	SS24	Active		527786	5632174
345	Sea spurge	SS25	Active		527790	5632128
346	Sea spurge	SS26	Active		527792	5632179
347	Sea spurge	SS029	Active		527800	5632237
348	Sea spurge	SS27	Active		527801	5632237
349	Sea Spurge	SS021			527809	5631957
350	Sea spurge	SS28	Active		527809	5632179
351	Sea spurge	SS29	Active		527810	5632231
352	Sea spurge	SS023	Active		527811	5632392
353	Sea spurge	SS30	Active		527811	5632392
354	Sea spurge	SS31	Active		527814	5632081
355	Sea spurge	SS32	Active		527826	5632318
356	Sea spurge	SS33	Active		527828	5632141
357	Sea spurge	SS34	Active		527829	5632255
358	Sea spurge	SS35	Active		527832	5632163
359	Sea spurge	SS36	Active		527842	5632199
360	Sea spurge	SS37	Active		527842	5632308
361	Sea Spurge	SS031			527851	5632129
362	Sea spurge	SS030	Active		527857	5632193
363	Sea spurge	SS38	Active		527857	5632194
364	Sea Spurge	SS064			527858	5632096
365	Sea spurge	SS090	Active		527861	5632157
366	Sea spurge	SS39	Active		527862	5632158
367	Sea spurge	SS09	Active		527887	5632347
368	Sea Spurge	SS007			527888	5632140
369	Sea spurge	SS049	Active		527890	5632135
370	Sea spurge	SS40	Active		527891	5632135
371	Sea spurge	SS023	Active		527891	5632289
372	Sea spurge	SS41	Active		527892	5632290
373	Sea spurge	SS42	Active		527893	5632361
374	Sea spurge	SS014	Active		527899	5632127
375	Sea spurge	SS011	Active		527900	5632390
376	Sea spurge	SS08	Active		527905	5632339
377	Sea spurge	SS02	Active		527911	5632296
378	Sea spurge	SS050	Active		527917	5632101
379	Sea spurge	SS43	Active		527917	5632101
380	Sea spurge	SS045	Active		527919	5632178
381	Sea spurge	SS44	Active		527919	5632178
382	Sea spurge	SS45	Active		527923	5632301
383	Sea Spurge	SS008			527926	5632121
384	Sea spurge	SS03	Active		527932	5632271
385	Sea spurge	SS46	Active		527934	5632339
386	Sea spurge	SS046	Active		527942	5632235

Id	Weed	Site	Status	Date	Easting	Northing
387	Sea spurge	SS47	Active		527942	5632236
388	Sea spurge	SS48	Active		527943	5632312
389	Sea spurge	SS047	Active		527946	5632258
390	Sea spurge	SS49	Active		527946	5632259
391	Sea spurge	SS50	Active		527949	5632332
392	Sea spurge	SS048	Active		527965	5632288
393	Sea spurge	SS51	Active		527966	5632289
394	Sea spurge	SS07	Active		527967	5632316
395	Sea Spurge	SS027		10/05/2021	527971	5632148
396	Sea Spurge	SS028		10/05/2021	527976	5632123
397	Sea Spurge	SS047		10/05/2021	527979	5632288
398	Sea Spurge	SS065		10/05/2021	527994	5631994
399	Sea Spurge	SS029		10/05/2021	528013	5632113
400	Sea spurge	SS52	Active		528144	5632273
401	Sea Spurge	SS037		10/05/2021	528201	5632309
402	Sea Spurge	SS063			529834	5630976

Note: Status: active indicates that weeds found in previous 12 months;
easting and northing: GDA94/55.

Little Squally Cove from Barn Hill

Appendix 3b. Active weed sites point location data

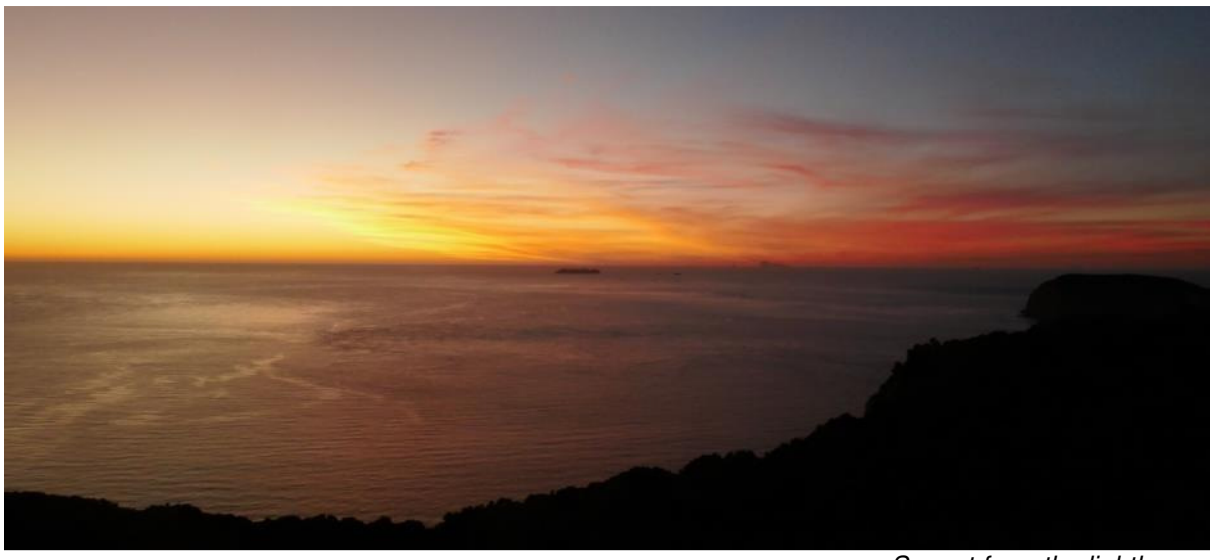
Note: Patches of ragwort have been mapped separately as polygons.

Id	Weed	Site	Type	Easting	Northing
1	Arum lily	AL1	minor	526927	5630734
2	Arum lily	AL10	minor	527096	5630681
3	Arum lily	AL11	minor	527316	5630710
4	Arum lily	AL12	minor	527427	5630742
5	Arum lily	AL13	minor	527523	5630766
6	Arum lily	AL14	minor	527704	5629211
7	Arum lily	AL2	minor	526955	5630756
8	Arum lily	AL3	minor	526998	5630765
9	Arum lily	AL4	major	527011	5630738
10	Arum lily	AL5	minor	527022	5630721
11	Arum lily	AL6	minor	527034	5630736
12	Arum lily	AL7	minor	527051	5630705
13	Arum lily	AL8	minor	527055	5630550
14	Arum lily	AL9	minor	527056	5630698
15	Great mullein	G1	minor	527061	5630701
16	Great mullein	G10	minor	527322	5630852
17	Great mullein	G11	minor	527336	5630889
18	Great mullein	G12	minor	527368	5630967
19	Great mullein	G13	minor	527381	5630862
20	Great mullein	G14	minor	527432	5630734
21	Great mullein	G15	minor	527928	5632081
22	Great mullein	G16	minor	527560	5630687
23	Great mullein	G17	minor	529421	5630898
24	Great mullein	G18	minor	528010	5632116
25	Great mullein	G19	major	529423	5630869
26	Great mullein	G2	minor	527236	5630793
27	Great mullein	G3	minor	527245	5630811
28	Great mullein	G4	minor	527265	5630835
29	Great mullein	G5	minor	527274	5630850
30	Great mullein	G6	minor	527287	5630831
31	Great mullein	G7	minor	527311	5630826
32	Great mullein	G8	minor	527313	5630850
33	Great mullein	G9	minor	527322	5630834
34	Horehound	HH1	minor	526522	5630457
35	Marram grass	MG1	minor	527906	5632395
36	Ragwort	RG1	minor	527798	5632087
37	Ragwort	RG3	minor	527948	5632256
38	Ragwort	RG4	minor	527690	5632414
39	Ragwort	RG5	minor	527769	5632423
40	Ragwort	RW10	minor	527081	5630595
41	Ragwort	RW11	minor	527378	5632176
42	Ragwort	RW2	minor	527061	5630705
43	Ragwort	RW6	minor	527698	5632168
44	Ragwort	RW7	minor	527815	5631959
45	Ragwort	RW8	minor	527946	5632008
46	Ragwort	RW9	minor	528060	5631328
47	Ragwort	RW12	minor	527019	5630748
48	Sea spurge	SS1	minor	526956	5629915
49	Sea spurge	SS2	major	526610	5630457
50	Sea spurge	SS3	minor	529766	5630710
51	Sea spurge	SS4	minor	529737	5630786
52	Sea spurge	SS5	minor	529745	5630860
53	Sea spurge	SS6	minor	529778	5630913
54	Sea spurge	SS7	major	527809	5632161
55	Sea spurge	SS8	major	527831	5632182
56	Sea spurge	SS9	major	527756	5632229

Id	Weed	Site	Type	Easting	Northing
57	Sea spurge	SS10	major	527861	5632245
58	Sea spurge	SS11	major	527892	5632311
59	Sea spurge	SS12	minor	527831	5632324
60	Sea spurge	SS13	minor	527857	5632331
61	Sea spurge	SS14	major	527758	5632339
62	Sea spurge	SS15	minor	527900	5632373
63	Sea spurge	SS16	minor	527901	5632391
64	Sea spurge	SS17	major	527883	5632395
65	Sea spurge	SS18	minor	527790	5632404
66	Sea spurge	SS19	minor	526921	5630585
67	Sea spurge	SS20	minor	526941	5630654
68	Sea spurge	SS21	minor	526803	5630492
69	Sea spurge	SS22	minor	526777	5630478
70	Sea spurge	SS23	minor	524481	5633621
71	Sea spurge	SS24	minor	527712	5632390
72	Sea spurge	SS25	minor	527719	5632089
73	Sea spurge	SS26	major	526930	5630600
74	Sea spurge	SS27	minor	527727	5632271
75	Sea spurge	SS28	major	526834	5630509
76	Sea spurge	SS29	minor	527736	5632128
77	Sea spurge	SS30	major	527899	5632127
78	Sea spurge	SS31	minor	527751	5632234
79	Sea spurge	SS32	minor	527751	5632352
80	Sea spurge	SS33	minor	527758	5632113
81	Sea spurge	SS34	minor	527763	5632158
82	Sea spurge	SS35	minor	527772	5632350
83	Sea spurge	SS36	minor	527775	5632424
84	Sea spurge	SS37	major	527912	5632296
85	Sea spurge	SS38	minor	524513	5633624
86	Sea spurge	SS39	minor	527776	5632173
87	Sea spurge	SS40	minor	527777	5632348
88	Sea spurge	SS41	minor	527784	5632212
89	Sea spurge	SS42	minor	527784	5632409
90	Sea spurge	SS43	minor	527786	5632174
91	Sea spurge	SS44	minor	527790	5632128
92	Sea spurge	SS45	minor	527792	5632179
93	Sea spurge	SS46	minor	527801	5632237
94	Sea spurge	SS47	minor	527809	5632179
95	Sea spurge	SS48	minor	527810	5632231
96	Sea spurge	SS49	minor	527933	5632271
97	Sea spurge	SS50	minor	527675	5632277
98	Sea spurge	SS51	minor	527811	5632392
99	Sea spurge	SS52	minor	527814	5632081
100	Sea spurge	SS53	minor	527826	5632318
101	Sea spurge	SS54	minor	527828	5632141
102	Sea spurge	SS55	minor	527829	5632255
103	Sea spurge	SS56	minor	527832	5632163
104	Sea spurge	SS57	minor	527842	5632199
105	Sea spurge	SS58	minor	527842	5632308
106	Sea spurge	SS59	minor	527857	5632194
107	Sea spurge	SS60	minor	527862	5632158
108	Sea spurge	SS61	minor	527685	5632401
109	Sea spurge	SS62	minor	527891	5632136
110	Sea spurge	SS63	minor	527892	5632290
111	Sea spurge	SS64	minor	527893	5632361
112	Sea spurge	SS65	minor	527917	5632101
113	Sea spurge	SS66	major	527924	5632124
114	Sea spurge	SS67	minor	527919	5632178

Id	Weed	Site	Type	Easting	Northing
115	Sea spurge	SS68	minor	527923	5632301
116	Sea spurge	SS69	minor	527934	5632339
117	Sea spurge	SS70	minor	527942	5632236
118	Sea spurge	SS71	minor	527943	5632312
119	Sea spurge	SS72	minor	527946	5632259
120	Sea spurge	SS73	minor	527697	5632209
121	Sea spurge	SS74	minor	527949	5632332
122	Sea spurge	SS75	minor	527966	5632289
123	Sea spurge	SS76	minor	528144	5632273
124	Sea spurge	SS77	minor	527697	5632387
125	Sea spurge	SS78	minor	527967	5632316
126	Sea spurge	SS79	minor	527700	5632407
127	Sea spurge	SS80	minor	527905	5632340
128	Sea spurge	SS81	minor	527703	5632385
129	Sea spurge	SS82	minor	527709	5632217
130	Sea spurge	SS83	major	527887	5632348
131	Sea spurge	SS84	major	526685	5630491

Note: minor sites contained only juvenile plants and/or only a few plants while major sites contained mature and/or a moderate to large number of plants.
Major sites need to be follow-up weeded every three months to ensure the weeds do not become re-established.



Sunset from the lighthouse