



Vegetation recovery after the 2019 and 2020 bushfires on K'gari (Fraser Island) Great Sandy National Park

South-east Queensland Bioregion

Prepared by: Queensland Herbarium, Science and Technology Division, Department of Environment and Science

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Introduction

On 14 October 2020, a bushfire was reported following an illegal campfire near Orange Creek, at the north-east of K'gari (Fraser Island). Several factors contributed to the fire spreading, including high temperatures, strong dry northerly winds, complex vegetation structures and types, difficult terrain and remote and limited access constrained by dry, loose sand tracks. During the two-month response, the bushfire travelled from the north of the island southwards towards the Kingfisher Bay Resort. In this time, it posed a threat to a number of townships campgrounds and significant cultural sites for the Butchulla people. Despite the efforts of the response personnel from Queensland Parks and Wildlife Service and Partnerships (QPWS&P) and Queensland Fire and Emergency Services (QFES), the fire burnt through 85,000 hectares, which is more than half the area of the island (Inspector-General Emergency Management 2021) as shown in Figure 1. Meiklejohn et al. (2021) calculate the area impacted as 75,100 hectares.

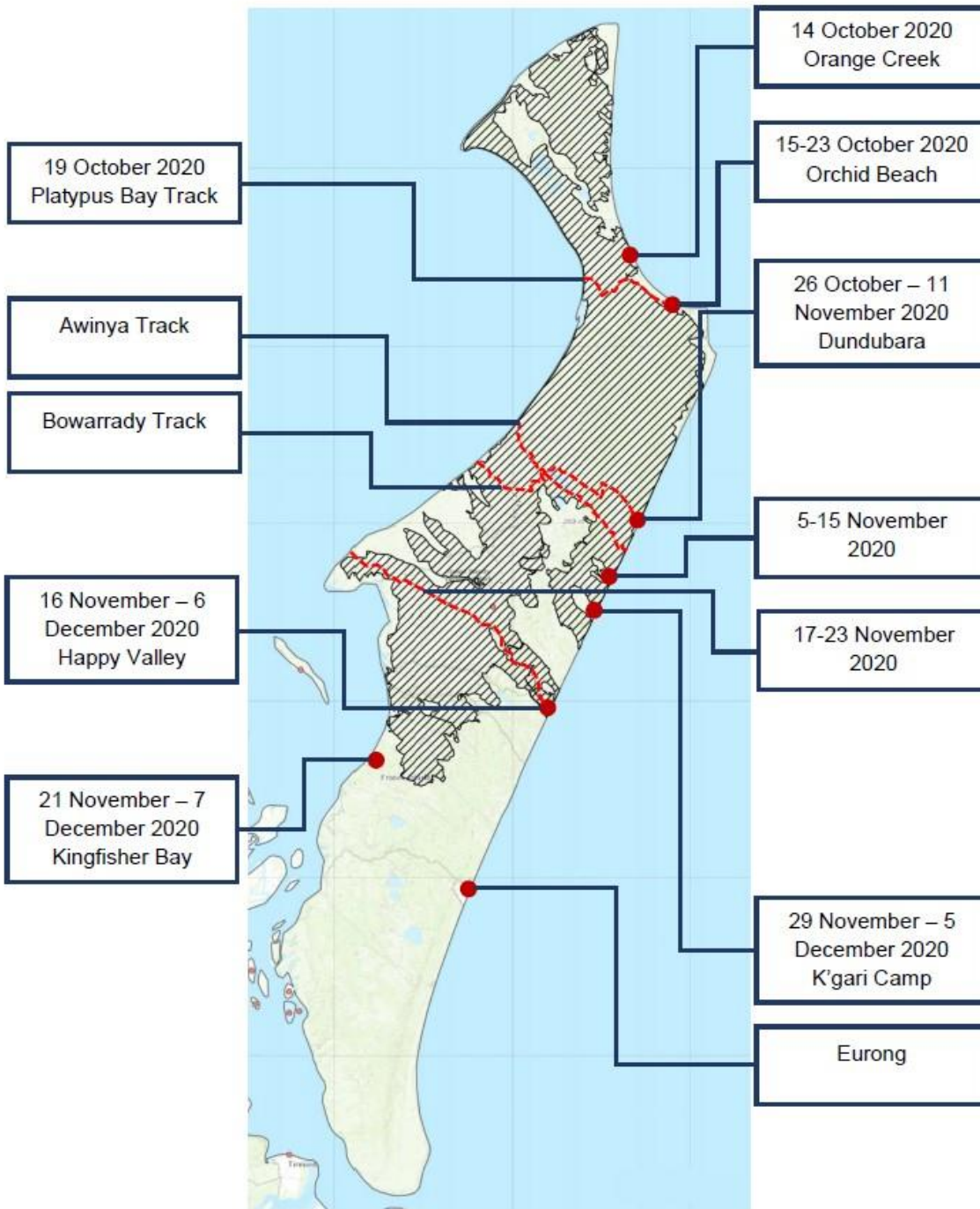


Figure 1. Burnt area map of K'gari (Fraser Island) as at 23 March 2021 (Inspector-General Emergency Management 2021)



There was also a large area of southern K'gari that was burnt in a wildfire in November 2019 and the burnt areas have been mapped using Visible Infrared Imaging Radiometer Suite (VIIRS) coverage (NASA 2020) by Smith et al. (2021) as shown in Figure 2.

Fire management is an important part of QPWS&P management of Great Sandy National Park. QPWS&P uses the principles in the Planned Burn Guidelines – Southeast Queensland Bioregion of Queensland (QPWS 2013) in conjunction with the Regional Ecosystem fire guidelines (Queensland Herbarium 2021) to plan fire management activities. The ability to implement these plans is dependent on suitable weather and other management issues.

The vegetation of Fraser Island was mapped at 1:25 000 scale by Peter Stanton in 1975. This high-quality vegetation mapping was converted into regional ecosystems and has been part of the state-wide regional ecosystem coverage since 2000. However there has not been a comprehensive vegetation site sampling within the Island that has been captured in the Queensland Herbarium's Queensland Biodiversity and Ecology Information System (QBEIS) or other government databases. There are 56 permanently marked biodiversity monitoring sites set up as part of Marc Hockings/QPWS&P studies in 1995 (Hockings and Hobson 2000; hereafter Hockings sites) but these have not been previously digitised. Scanned copies of handwritten site data sheets and GIS coverages of their locations were obtained from QPWS&P to assist in locating the marked sites on the Island.

Figure 2. Extract of map of burnt areas (red) from 1 September to 31 December 2019 from Smith et al. (2021).

The central part of Fraser island was declared a forestry reserve in 1908, and the whole of the island declared State Forest by 1925. Sixty-one Native Forest Growth Plots (NFP) were established and recorded during the State Forest years. The location details of these sites and lack of maintenance makes it difficult to relocate these sites. Of the NFP plots, there are four Montreal Forest Monitoring Plots that have been resampled in recent times. In 1971 the northern third of the K'gari was declared a Queensland National Park. The National Park was extended in 1992, when World Heritage listing was granted to include all of the island as a section of Great Sandy National Park. Harvesting of blackbutt forests and other silvicultural activities ceased in December 1991 when the island was gazetted National Park (Applegate 2020).

The purpose of this project was to establish detailed vegetation survey plots, i.e. QBEIS (Queensland Biodiversity and Ecology Information System) vegetation sites, in areas that were burnt in the 2019 and 2020 bushfires so that post-fire recovery can be assessed and monitored.

Methods

In order to assess post fire recovery from the November 2019 and October to December 2020 bushfire (hereafter 2020 bushfire) on the vegetation, information and locations of any previously marked vegetation monitoring sites on Great Sandy National Park were sourced. The 56 permanently marked sites set up as part of Marc Hockings/QPWS studies in 1995 onwards were deemed the best available pre-fire vegetation sites (Hockings and Hobson 2000). These sites were routinely sampled between August and November and many of them had been re-sampled in 1996 and 1997. Some of the sites were re-sampled up to four times on a yearly basis after establishment but then were not re-sampled after 2003. Scanned copies of the site data were obtained and GIS coverages of their locations produced to assist in re-location. The sites had been marked with a wooden post painted white with the sampling number engraved into it and painted green and located beside the nearest vehicle track (See examples in Figure 3). However no detail was provided on the marker post of the distance or bearing to the star pickets which formed the origin of the plot. The size and shape of the plot surveyed varied, and its orientation was also not documented. The size of the plots ranged from 5 m² to 20 m². Species/area curves for each site were calculated and plot sizes selected to contain at least 90% of the total estimated number of species present (Hockings and Hobson 2000). A comprehensive list of vascular plants on each plot was captured and a Braun Blanquet cover abundance ranking provided for all species. Photos were also taken and stored at each sampling event but could not be located for this study. A map showing the location and distribution of the Hockings' sites is presented in Figure 4.



Figure 3. Wooden post trackside markers for Hockings/QPWS sites 32 and 47.

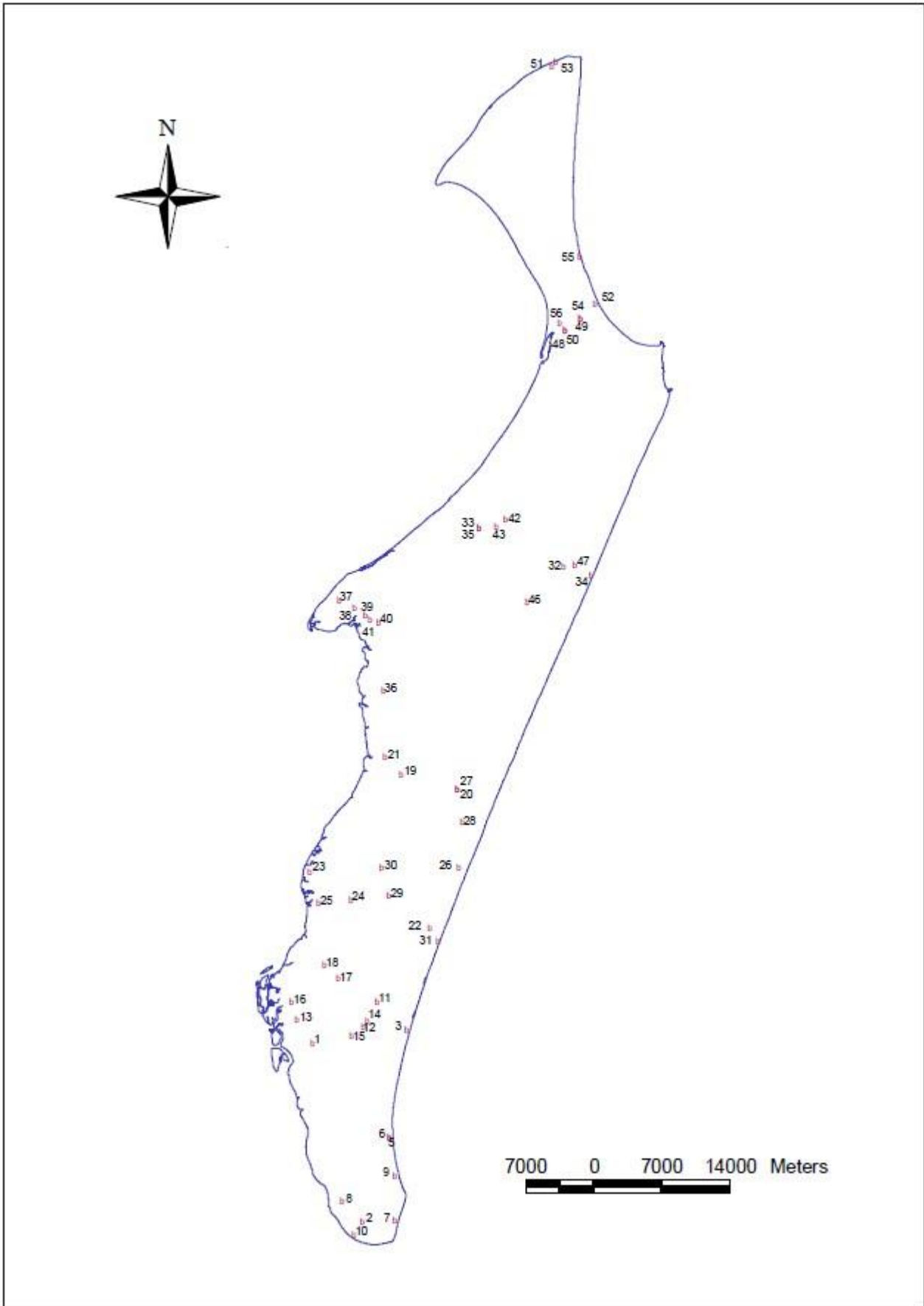


Figure 4. Location of Hockings/QPWS sites established in 1995.

The Queensland Herbarium field work was conducted in April 2021 in collaboration with QPWS&P (Figure 5). An attempt was made to locate all accessible Hockings sites and to overlay them with a 50 x 10 m, QLD Herbarium standard QBEIS (Queensland Biodiversity and Ecology Information System) vegetation monitoring site. If the original star pickets were located they were used as the origin of the QBEIS rectangular site (50 x 10 metres), with as much overlap with the area presumed to have been sampled by the Hockings' plots. The standard QBEIS methodology (Neldner et al. 2019) was followed, which stratified the vegetation into layers, and recorded canopy cover, density and height for all species. The basal area of the site was recorded both by using the Bitterlich method and measuring of all woody plants within the plot that were greater than two centimetres in diameter at breast height (DBH). The amount of coarse woody debris (CWD) within the plot was also measured. Where a Hockings site could not be located, a new QBEIS site was established at the location and in the same vegetation indicated in the Hockings data. Where plants could not be identified in the field (many heath shrubs were not fertile at the time), a specimen was collected and dried, and later identified at the Queensland Herbarium.

Once plant identification was completed the data was entered into QBEIS database. A way to assess the relative condition of the sampled vegetation was to compare its BioCondition attributes derived using the methodology of Eyre et al. (2016) with a benchmark for the same regional ecosystem. This comparison was made with established benchmarks for the nine regional ecosystems (REs) sampled in April 2021 (see Appendix 1 for benchmark values), and the results were displayed in radar diagrams. BioCondition uses ten attributes to compare to the Benchmark attribute scores, and produces an overall BioCondition score. All attributes have the same weighting, except for non-native plant cover (a measure of weediness) which has double the weight, and number of large trees (a surrogate for fauna habitat, particularly tree hollows) which has three times the weight of other attributes. The sites sampled in this study were generally non-weedy, i.e. only a low cover in non-native plants, however some were also low in large trees which significantly influenced the final BioCondition score. The weighting difference should be remembered when interpreting the BioCondition radar diagrams in this report. The landscape attributes (patch size, connectivity) have not been used in this assessment because of the non-fragmented landscape. For non-woody REs, there are few attributes to used in the BioCondition assessment, but they have been standardised to give a maximum score of 100 for all RE types.



Figure 5. Herbarium botanists Michael Ngugi and John Neldner conducting vegetation surveys with QPWS staff Russ Simkins and Megan Wilson

Results

Thirty QBEIS sites were permanently marked, sampled and databased. Some of these were part of the 56 Hockings sites established between 1995 and 1999 (see Appendix 2). The re-visit of 12 sites was not attempted because of logistic or time constraints. Seventeen sites were searched for but could not be re-located. In all, 24 sites were successfully located, with the trackside marker missing for only one of these. Five Hocking sites (6, 25, 39, 40 and 41) were relocated and photographed but not re-sampled because of lack of time. Nineteen Hockings sites were revisited and a QBEIS site established. Six QBEIS sites were established near the expected Hockings site location, but the star picket could not be found (19R, 21R, 24R, 29R, 36R, 48R). An additional five new QBEIS sites (Cornwall 1 & 2, Deep, Eurong and Happy) were established. Of the 30 QBEIS sites established, eighteen were burnt in the October 2020 fire and four in the November 2019 fire and the rest (eight sites) were unburnt in either year. The 30 sites are all databased in QBEIS. The details of site locations are given in Appendix 2. The number and proportion of live and dead trees at each tree-dominated site is provided in Table 1. Eighty voucher specimens were incorporated into the Queensland Herbarium specimen collection.

Table 1. Number and proportion of trees that were alive and dead[#] during the 2020 post-fire assessment in each tree-dominated site in Fraser Island NP

Site name	Number of dead trees	Number of live trees	Total number of trees	% Alive	% Dead	Fire severity in Nov 2019 or Oct 2020	Dead tree species able to be identified within the plot
3	1	41	42	98	2	Unburnt	
11	3	76	79	96	4	Unburnt	<i>Acrotriche aggregata</i>
23	0	78	78	100	0	Unburnt	
30	0	42	42	100	0	Unburnt	
29R	0	74	74	100	0	Unburnt	
Cornwall1	6	60	66	91	9	Unburnt	<i>Monotoca scoparia</i>
Eurong	21	168	189	89	11	Unburnt	<i>Banksia aemula</i> , <i>Casuarina equisetifolia</i>
32	19	12	31	39	61	Low	<i>Allocasuarina torulosa</i> , <i>Corymbia intermedia</i> , <i>Endiandra sieberi</i> , <i>Monotoca scoparia</i>
37	1	83	84	99	1	Low	<i>Callitris columellaris</i>
47	11	5	16	31	69	Low	<i>Allocasuarina littoralis</i> , <i>Banksia integrifolia</i> , <i>Monotoca scoparia</i>
48R	4	19	23	83	17	Low	<i>Callitris columellaris</i> , <i>Monotoca scoparia</i>
49	5	25	30	83	17	Low	<i>Banksia aemula</i> , <i>Corymbia intermedia</i>
15	24	71	95	75	25	Moderate	<i>Allocasuarina littoralis</i> , <i>Banksia aemula</i>
22	0	25	25	100	0	Moderate	
24	0	77	77	100	0	Moderate	
38	25	24	49	49	51	Moderate	<i>Allocasuarina littoralis</i> , <i>Banksia aemula</i> , <i>Melaleuca quinquenervia</i>
43	21	27	48	56	44	Moderate	<i>Banksia aemula</i> , <i>Eucalyptus racemosa</i>
Cornwall2	83	27	110	25	75	Moderate	<i>Acmena smithii</i> , <i>Endiandra sieberi</i> , <i>Syncarpia hillii</i> (many resprouting at the base)
Deep Creek	4	75	79	95	5	Moderate	<i>Banksia aemula</i> , <i>Eucalyptus racemosa</i> , <i>Lophostemon suaveolens</i>

Site name	Number of dead trees	Number of live trees	Total number of trees	% Alive	% Dead	Fire severity in Nov 2019 or Oct 2020	Dead tree species able to be identified within the plot
13	28	38	66	58	42	High	<i>Allocasuarina littoralis</i> , <i>Endiandra sieberi</i> , <i>Eucalyptus latisinensis</i> , <i>Melaleuca quinquenervia</i>
33	24	87	111	78	22	High	<i>Banksia aemula</i> , <i>Eucalyptus racemosa</i> , <i>Eucalyptus latisinensis</i> , <i>Leptospermum trinervium</i>
34	23	0	23	0	100	High	<i>Banksia integrifolia</i> , <i>Casuarina equisetifolia</i> , <i>Polyscias elegans</i> , <i>Pandanus tectorius</i>
36R	71	14	85	16	84	High	<i>Allocasuarina littoralis</i>
42	45	55	100	55	45	High	<i>Banksia aemula</i> , <i>Elaeocarpus reticulatus</i> , <i>Eucalyptus racemosa</i> , <i>Leptospermum trinervium</i>
Opposite 19	2	24	26	92	8	High	<i>Melaleuca quinquenervia</i>
Happy	13	1	14	7	93	High	<i>Banksia integrifolia</i> , <i>Casuarina equisetifolia</i>

#Dead tree – it is difficult in some cases to be sure if a tree is dead without stem flow measurements. However our sampling was at least five months after the fire, so if there was no sign of any epicormic shoots on the tree trunk or at the base, the individual tree was assumed to be dead.

As no pre-fire sampling of the sites was done, it cannot be definitely concluded that all of the death of trees was caused by the November 2019 or October 2020 fire. However it is likely that most of the deaths particularly where the fires were high to extreme severity can be assumed to be caused by these fire events.

The actual DBH of dead trees at each site was collected in this study but is not presented in this report.

The fire severity was determined on the basis of the field observations in April 2021 and in most cases supported by the fire severity mapping produced by QPWS (Meiklejohn et al. 2021).

Regional Ecosystem 12.2.4. *Syncarpia hillii*, *Lophostemon confertus* tall open to closed forest on parabolic high dunes

This RE has a limited remnant extent of 10,000 hectares (Accad et. 2021) which mainly occurs on Fraser Island. Because of this limited extent which mirrors its pre-clearing extent, it is afforded the Vegetation Management Class of Of Concern. Three new QBEIS sites were established, with Cornwall2 (Q18250) being burnt in October 2020 and recording the lowest BioCondition score of 68 Figure 6 and Figure 7. A draft benchmark was produced based on limited data and may require some future revision. All three sites were deficient against the benchmark for tree and forb species richness.

Cornwall2 scored lower than the adjacent unburnt Cornwall1 site (Q18251) (Figure 6) and Pile Valley 29R site (Q18287) (Figure 8) for shrub cover and large trees. The fire appeared to be moderate fire severity with scorch of tree trunks to more than 6 metres. All of the ground layer, shrubs and most of the subcanopy trees were burned by the fire with some resprouting occurring. There was resprouting occurring at the base of the subcanopy trees of *Acmena smithii* and *Endiandra sieberi*, as well at the base of canopy trees *Syncarpia hillii* and *Lophostemon confertus*. There was a mass recruitment of *Eucalyptus pilularis* seedlings as well.

As can be seen in Figure 6, the primary impact of the October fire on the BioCondition score was a decrease in the shrub cover (burnt by the fire) and canopy cover (some leaf loss and crown scorch). The low score for large trees would have been a pre-fire condition, which may be a legacy of logging at the site. The fire management guidelines suggest that moderate to high intensity fires in late summer to autumn are ideal to maintain the RE structure with a minimum fire interval of 20 years (Queensland Herbarium 2020). It will be important to protect Cornwall2 from fires for the next 20 years.



Figure 6. Site Cornwall1 (Q18251) (left image) and the adjacent burnt Cornwall2 site (Q18250) (right) showing the scorched subcanopy trees mainly *Acmena smithii* and high cover of *Eucalyptus pilularis* seedlings.

2021 BioCondition Assessment for RE 12.2.4

- Cromwell1 BioCondition score of 75
- Site 29R BioCondition score of 90
- Cromwell2 (Burnt Oct 2020) BioCondition score of 68

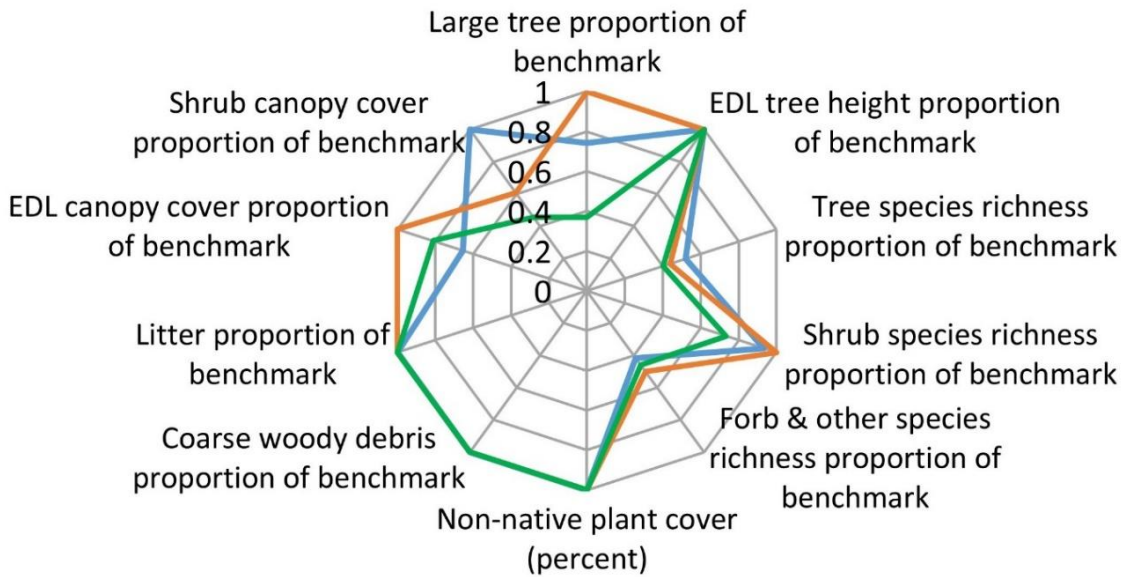


Figure 7. Radar diagram comparing the BioCondition scores of the three sites sampled in RE 12.2.4.



Figure 8. Site 29R (Q18287) *Syncarpia hillii*, *Lophostemon confertus* tall closed forest RE12.2.4 Pile Valley, Fraser Island.

Regional Ecosystem 12.2.5 *Corymbia intermedia* +/- *Lophostemon confertus* +/- *Banksia* spp. +/- *Callitris columellaris* open forest on beach ridges

One site, site 38 (Q18255), *Corymbia intermedia* woodland with *Melaleuca quinquenervia* and *Lophostemon suaveolens* was located in this RE, and while not matching the standard description it was the closest RE match. The site was burnt in the 2020 fire with the fire resulting in scorch of the subcanopy trees, shrubs and grass cover.

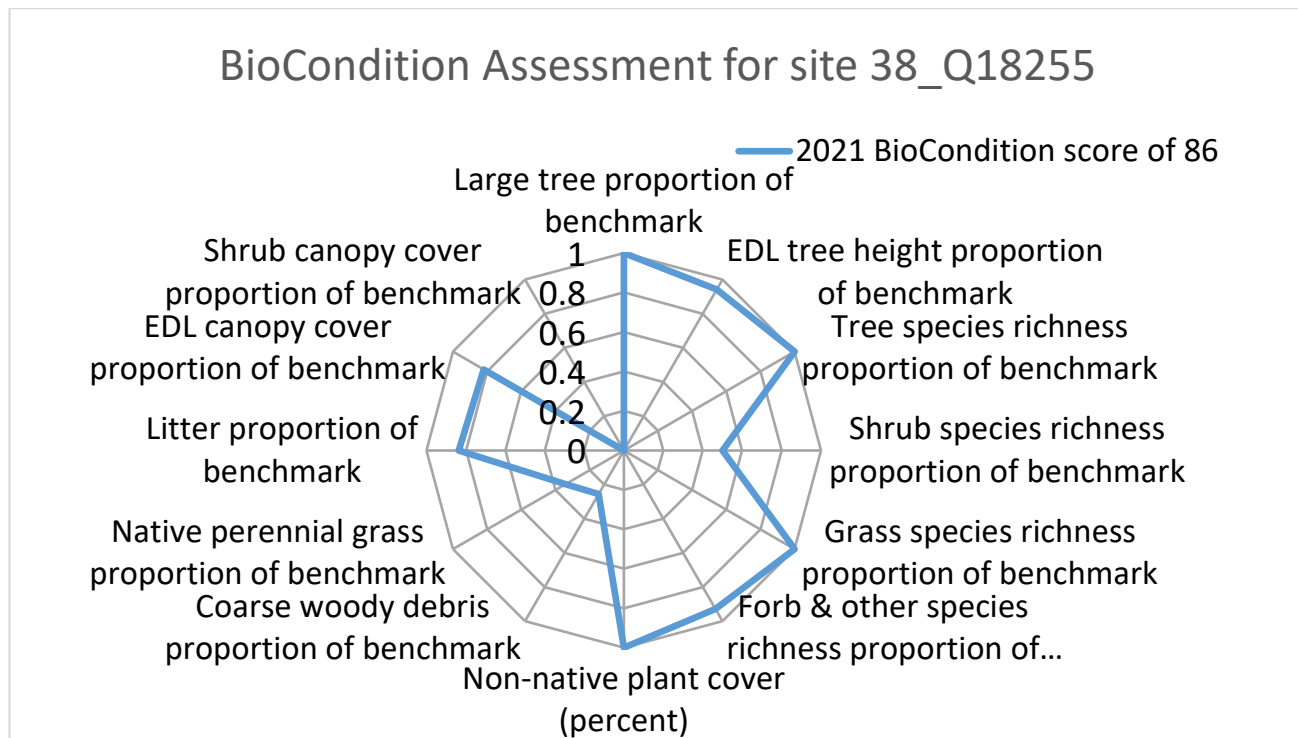


Figure 9. Radar diagram showing components of the BioCondition score for site 38 (Q18255).



The site had a high BioCondition score of 86 (Figure 9) with a deficiency in shrub cover and richness, and native perennial grass cover. However, the grass cover is recovering (Figure 10) and it is assumed that this site will continue to recover from the 2020 fire event.

Coarse woody debris was very low suggesting that the fire would have removed much of the coarse woody debris and this will take some time to recover.

The QH Regional Ecosystem' fire guidelines recommend that this RE not be burnt deliberately where it occurs in narrow beach ridge situations. However where more extensive occasional low severity fires are appropriate

Figure 10. Site 38 (Q18255) *Corymbia intermedia* woodland with *Melaleuca quinquenervia* and *Lophostemon suaveolens*

Regional Ecosystem 12.2.6 *Eucalyptus racemosa* subsp. *racemosa* open forest on dunes and sand plains.

This RE is widespread in coastal SEQ bioregion with a remnant extent in 2019 of 65000 hectares. Three sites (22 (Q18261), 24R (Q18263) and 11(Q18285)) that were not burnt (Figure 12) and six sites (43 (Q18249), 47 (Q18252), 33 (Q18256), 42 (Q18257), 36R (Q18260), 49 (Q18280)) that were burnt in October 2020 were sampled. The BioCondition scores of the individual sites were pooled to assist in interpretation of the effects of the October 2020 fire on these sites. The burnt sites had on average a low BioCondition score of 57 ranging from 35 to 81 in comparison to the unburnt sites which had an average score of 73 with scores ranging from 53 to 92. The lower scores were mainly caused by direct fire effects that reduced the shrub and canopy cover, perennial grass cover, litter cover and amount of coarse woody debris. It is expected that all of these attributes will continue to improve with time after fire.

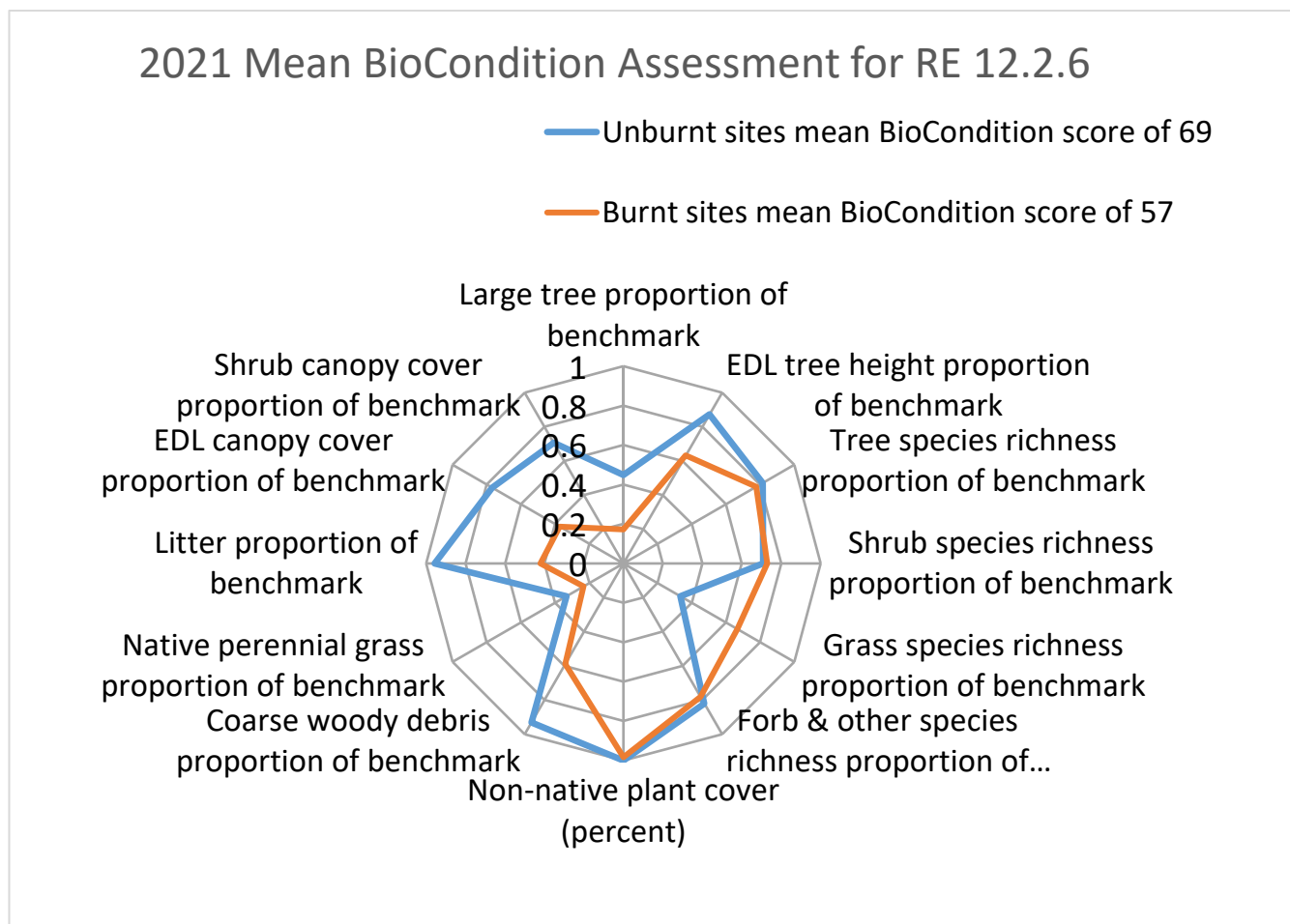


Figure 11. Radar diagram comparing the BioCondition scores of the nine sites sampled in RE 12.2.6



There was significant variability in the composition of this RE, particularly in the amount of shrub and ground cover and composition, in both the burnt and unburnt sites.

The fire management guidelines suggest that low to moderate intensity fires in late summer to winter are ideal to maintain the RE structure with a minimum fire interval of 2-6 years (Queensland Herbarium 2020). Intense fires during dry conditions damage grasses and promote dense shrub and small tree recruitment. Dense shrubs and small trees shade grasses and can draw flames into the canopy damaging eucalypt crowns. This promotes further dense shrub recruitment, which grows into dense thickets during subsequent long fire intervals, perpetuating the cycle. The loss of native grasses makes early-season, low-intensity fires more difficult to implement.

Figure 12. upper left site 11 with dense low tree shrub cover, upper right site 22 very low shrub cover and ground layer dominated by *Pteridium esculentum*, and the lower image site 24R with dense shrub cover.

Regional Ecosystem 12.2.6 sites that were not burnt in October 2020

Site 11 (Q18285) *Eucalyptus racemosa*, *Syncarpia hillii* shrubby woodland

BioCondition Assessment for site 11_18285

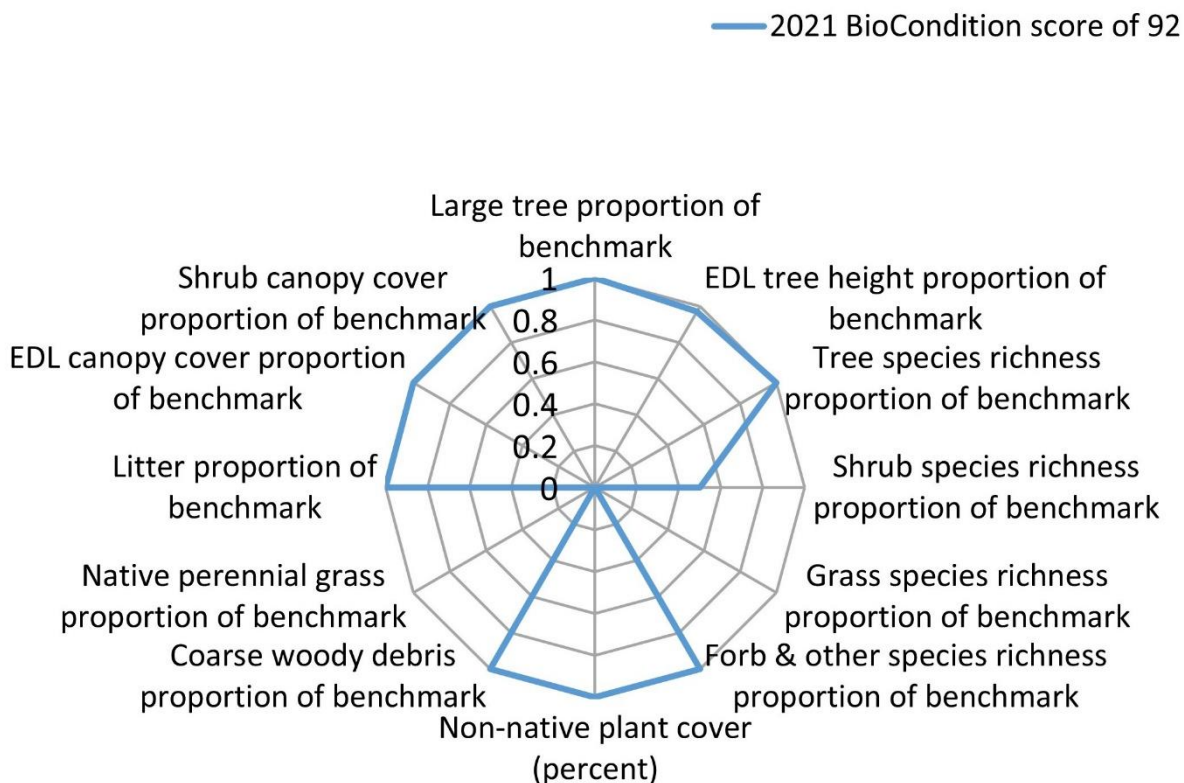


Figure 13. Radar diagram showing components of the BioCondition score for site 11 (Q18285).



Site 11 has a high BioCondition score of 92 (Figure 13) with only the lack of grass species and perennial grass cover and some shrub species richness being less than the benchmark. It was characterised by a mid-dense (47% canopy cover) T2 and T3 layer dominated by *Allocasuarina littoralis*, *Elaeocarpus reticulatus* and *Ricinocarpos pinifolius*. The shrub canopy cover was 37%, and very few ground layer species. It obviously had not been impacted by fire in the last 10 years.

Figure 14. Site 11 (Q18285) *Eucalyptus racemosa*, *Syncarpia hillii* shrubby woodland

Site 22 (Q18261) *Corymbia intermedia*, *Eucalyptus racemosa* open forest

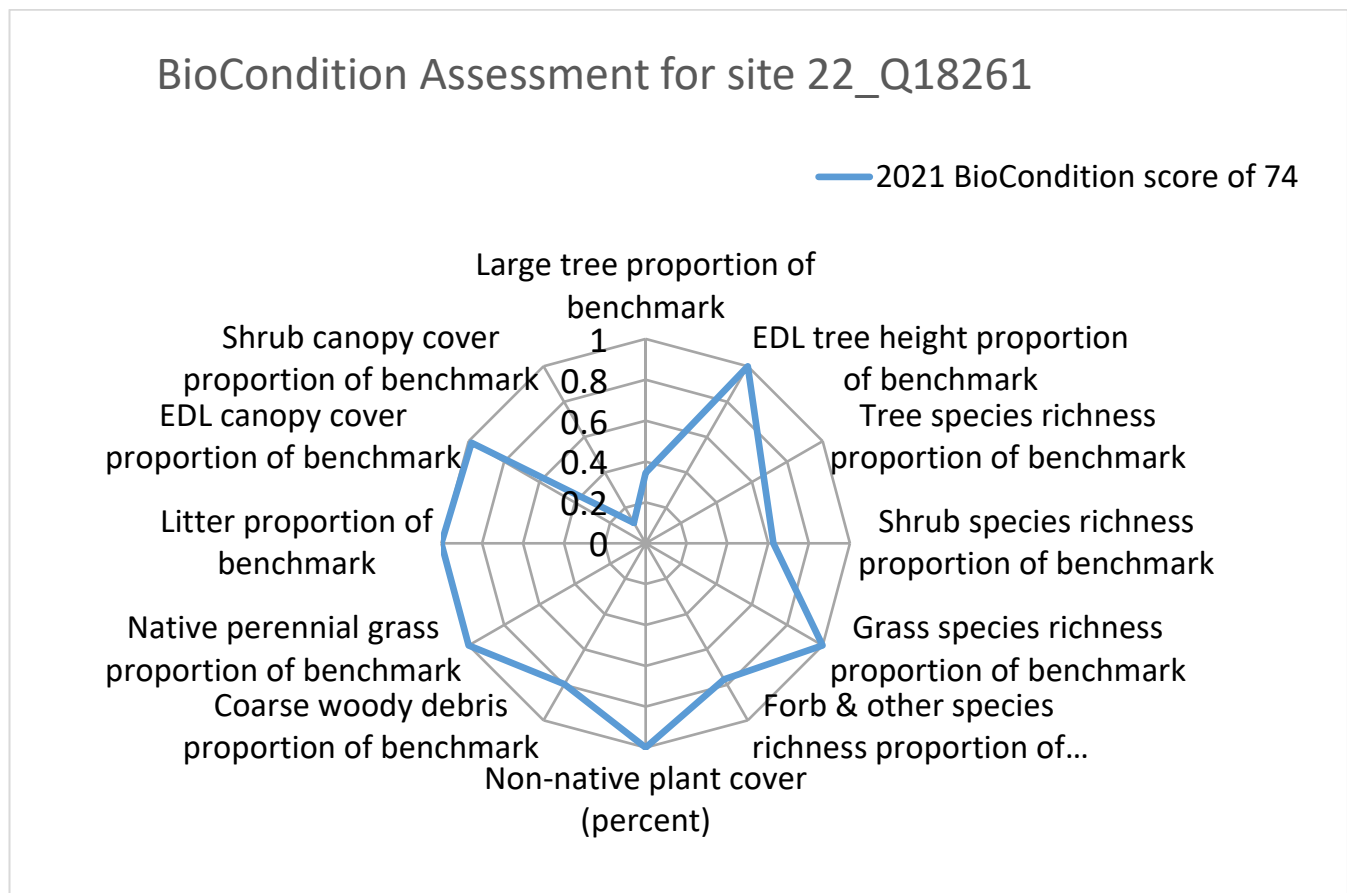


Figure 15. Radar diagram showing components of the BioCondition score for Site 22 (Q18261).



This site 22 has a BioCondition score of 74 (Figure 15) is characterised by moderately dense (57% canopy cover (CC)) T2 layer of *Allocasuarina littoralis* and *Corymbia intermedia*, with no distinct shrub layer and a moderately dense ground layer of *Pteridium esculentum* and perennial grasses *Themeda triandra* and *Imperata cylindrica* (Figure 16).

This site may be subject to a high fire frequency given its proximity to Eorong township which may favour a herbaceous ground layer.

Figure 16. Site 22 (Q18261) *Corymbia intermedia*, *Eucalyptus racemosa* open forest

Site 24R (Q18263) *Eucalyptus racemosa*, *Corymbia gummifera* woodland

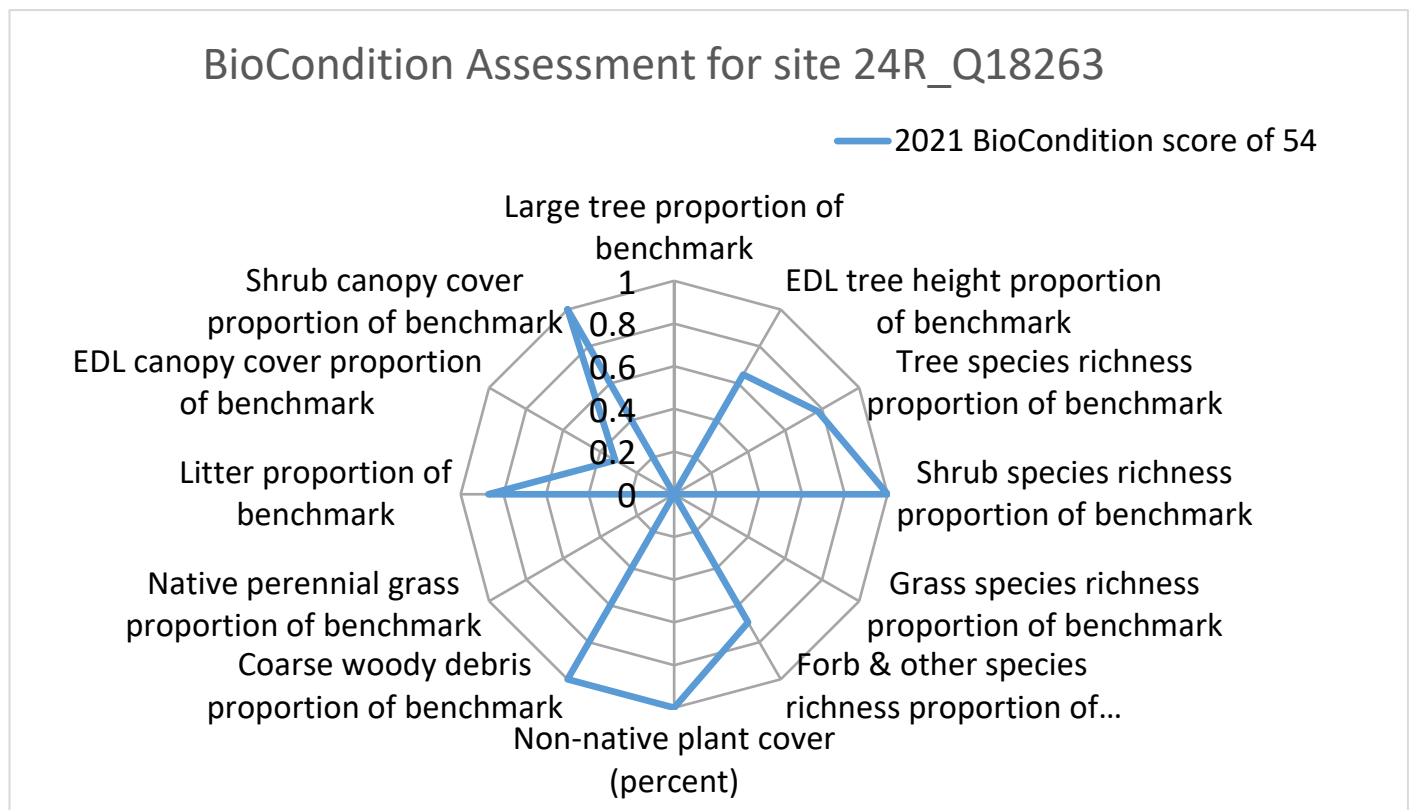


Figure 17. Radar diagram showing components of the BioCondition score for Site 24R (Q18263).



This site, 24R, had a BioCondition score of 54 (Figure 17) and experienced a high intensity fire in the last two years, probably in the November 2019 period. The tree canopy is relatively sparse (20% CC) while the T2 layer of *Banksia aemula* and *Corymbia gummifera* is mid-dense (48% CC). There is a dense shrub layer (*5% CC) dominated by *Xanthorrhoea johnsonii* and *Leptospermum trinervium* (Figure 18). The ground layer is very sparse and grasses are absent. The lack of grasses and the poor canopy height and cover and

lack of large trees has led this site to a low BioCondition score of 54.

Figure 18. Site 24R (Q18263) *Banksia aemula*, *Corymbia gummifera* woodland with *Eucalyptus racemosa*

Regional Ecosystem 12.2.6 sites that were burnt in October 2020

Site 33 (Q18256) Severely burnt *Eucalyptus racemosa*, *Banksia aemula* woodland.

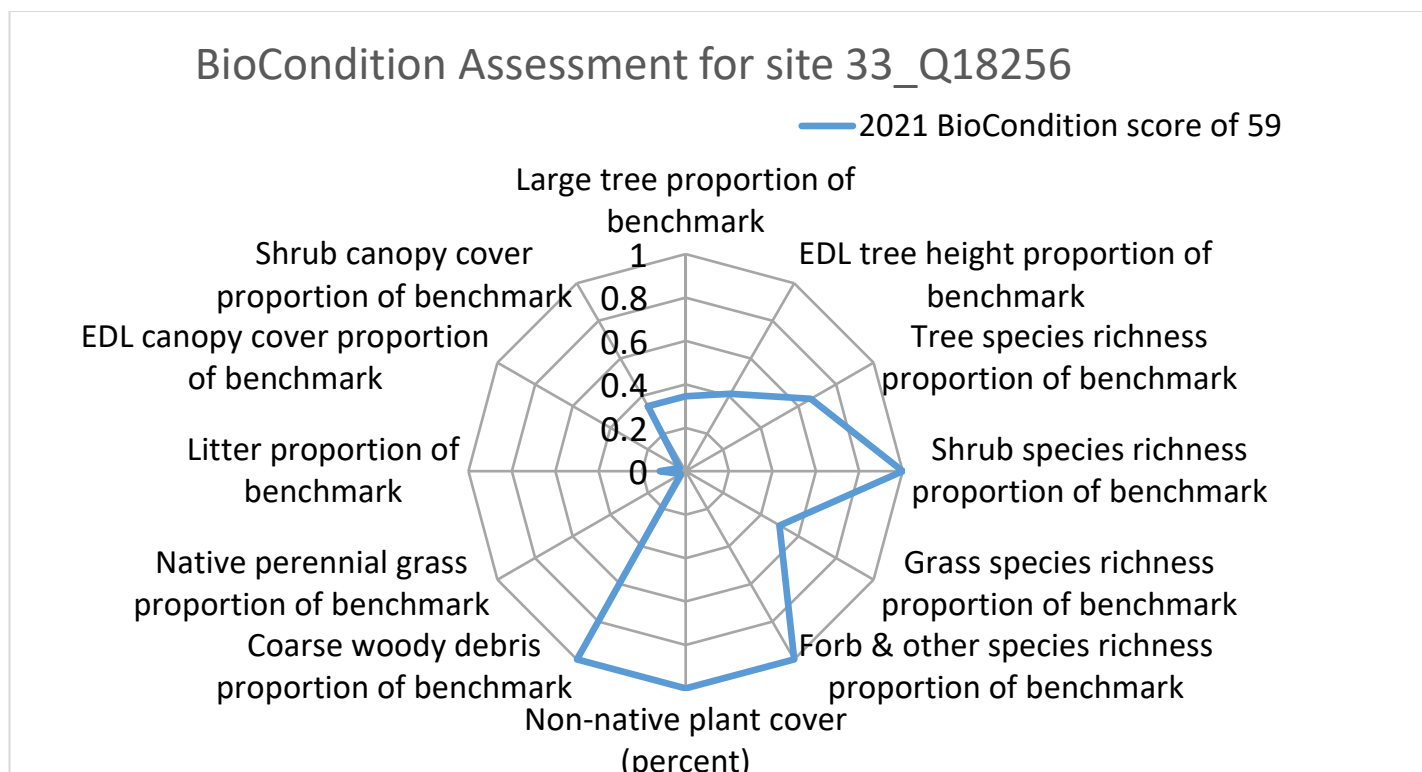


Figure 19. Radar diagram showing components of the BioCondition score for Site 33 (Q18256).



This site, 33, had a score of 59 and a low canopy of 7 metres tall. It had few large trees prior to the fire, but was severely impacted by the 2020 fire (Figure 20) (high to extreme fire severity at the site). It scored poorly for the tree canopy cover, height and richness attributes, and also for grass richness and perennial grass cover (Figure 19). Most of the expected shrub species are present and resprouting, so that shrub cover is likely to meet benchmark values within a short period of time.

Figure 20. Site 33 (Q18256) Severely burnt *Eucalyptus racemosa*, *Banksia aemula* woodland.

Site 36R (Q18260) Burnt *Corymbia intermedia*, *Lophostemon confertus* woodland

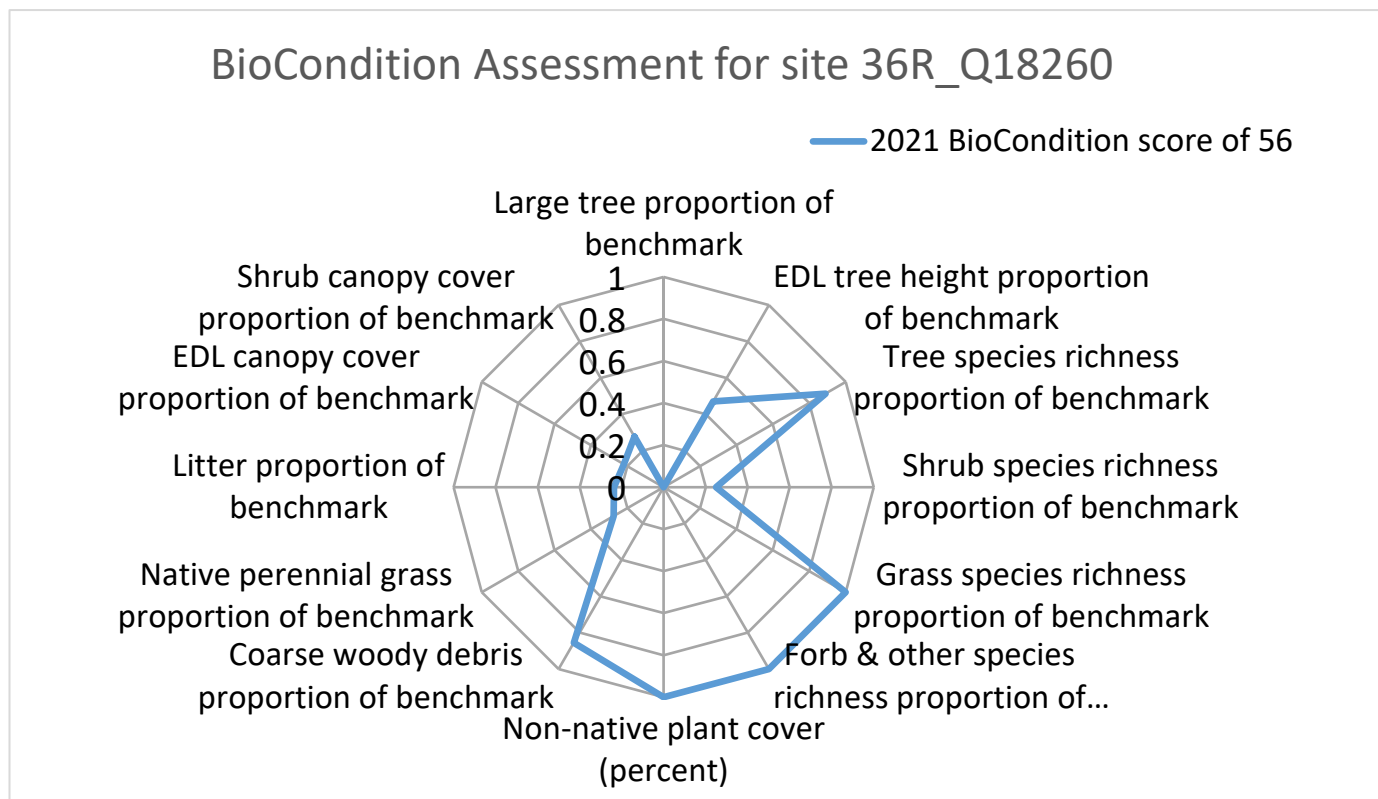


Figure 21. Radar diagram showing components of the BioCondition score for Site 36R (Q18260)



This site, 36R, had a BioCondition score of 56 (

Figure 21). It was severely burnt. The canopy of *Lophostemon confertus* and *Banksia aemula* was low (8m tall) with an 19m tall emergent *Eucalyptus pilularis* present (Figure 22). The sparse shrub and ground layer was predominantly composed of new seedlings of *Acacia penninervis* var. *longiracemosa* and resprouting from the base *L. confertus*. This site had a low BioCondition score because of low

canopy tree and shrub cover. There was also a lack of large trees, perennial grasses and litter cover.

Figure 22. Site 36R (Q18260) Burnt *Corymbia intermedia*, *Lophostemon confertus* woodland

Site 42 (Q18257) Burnt *Eucalyptus racemosa*, *Corymbia gummifera* woodland

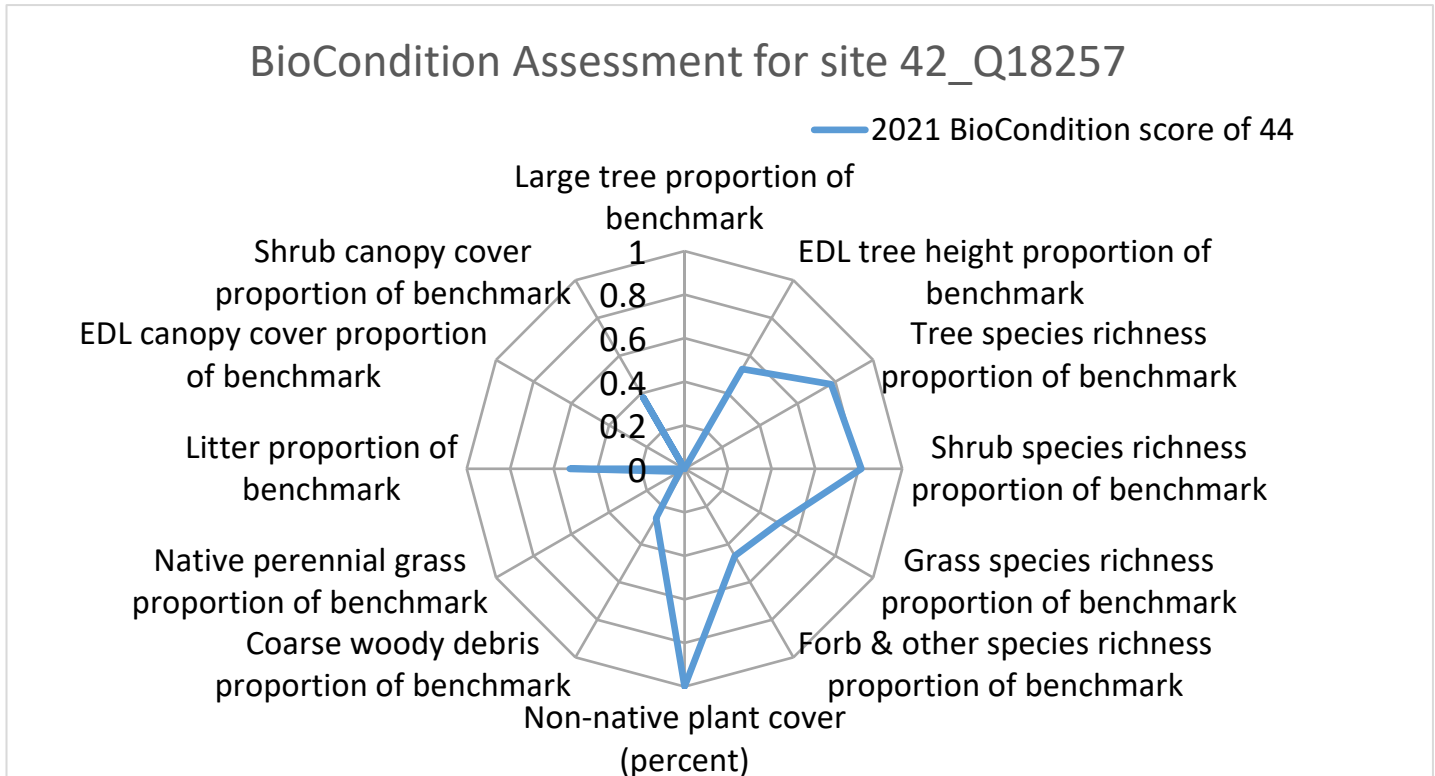


Figure 23. Radar diagram showing components of the BioCondition score for Site 42 (Q18257)



This site, 42, had a BioCondition score of 44 (Figure 23). The fire scorched up to 8m on the tree trunks and killed a third of the T2 layer and most of the shrubs (Figure 24). There are resprouting shrubs and germinating legumes but many bare areas. A clump of resprouting *Syncarpia hillii* is adjacent the plot. The low BioCondition score is explained by the low canopy height and cover, the lack of large

trees, coarse woody debris and perennial grasses.

Figure 24. Site 42 (Q18257) Burnt *Eucalyptus racemosa*, *Corymbia gummifera* woodland

Site 43 (Q18249) Burnt *Eucalyptus racemosa*, *Corymbia gummifera* low woodland

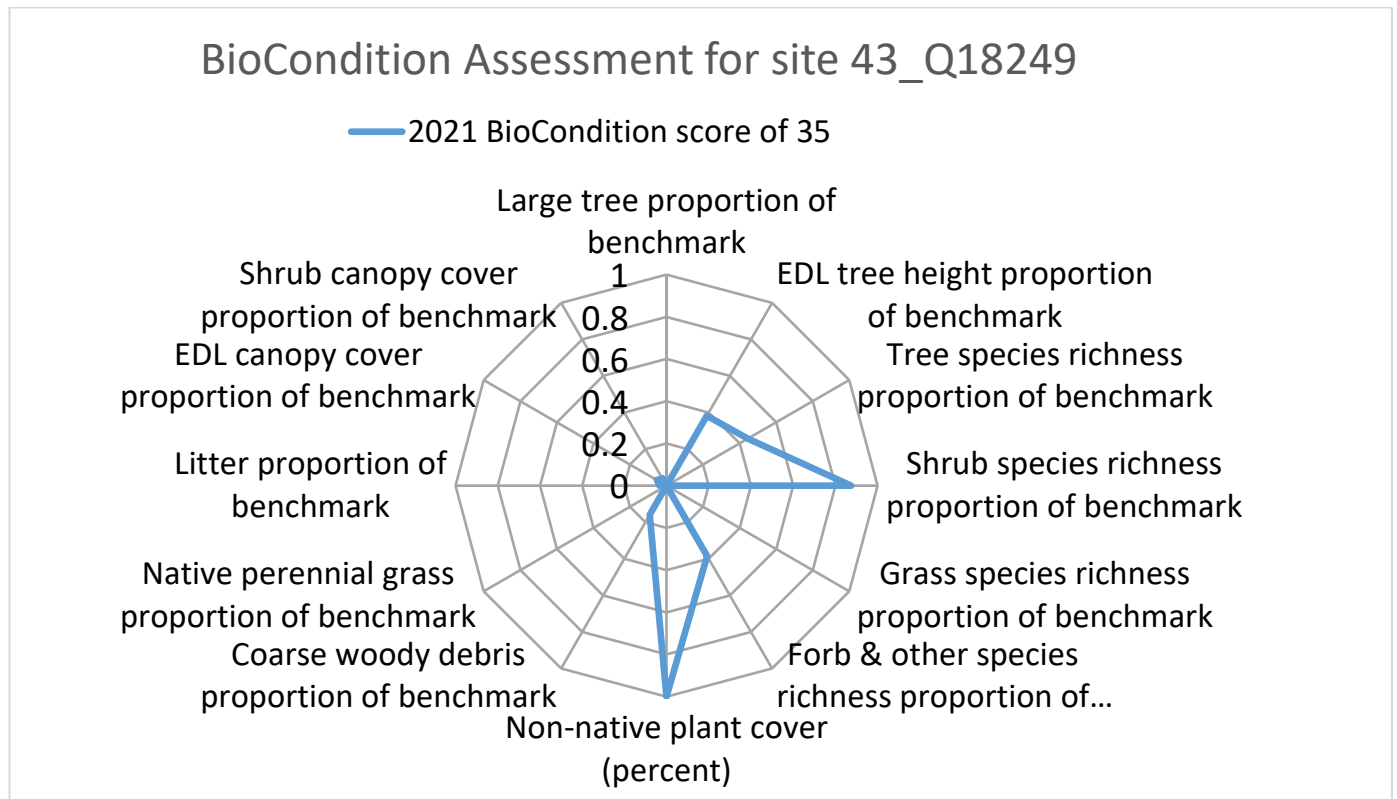


Figure 25. Radar diagram showing components of the BioCondition score for Site 43 (Q18249)



The BioCondition score for site 43 was 35 (Figure 25). This site was a low (6.5 m tall) woodland with no large trees prior to the 2020 fire and like site 42 has been mapped as 12.2.9. The burnt *Eucalyptus racemosa*, *Corymbia gummifera* and *Banksia aemula* low trees are resprouting on the stem and the base Figure 26. There is a lack of grass and many forb species, while most shrub species are regenerating. The low BioCondition score is also caused by the lack of litter, coarse woody debris, tree, shrub and grass cover.

Figure 26. Site 43 (Q18249) Burnt *Eucalyptus racemosa*, *Corymbia gummifera* low woodland

Site 47 (Q18252) *Corymbia intermedia*, *Lophostemon confertus* open forest.

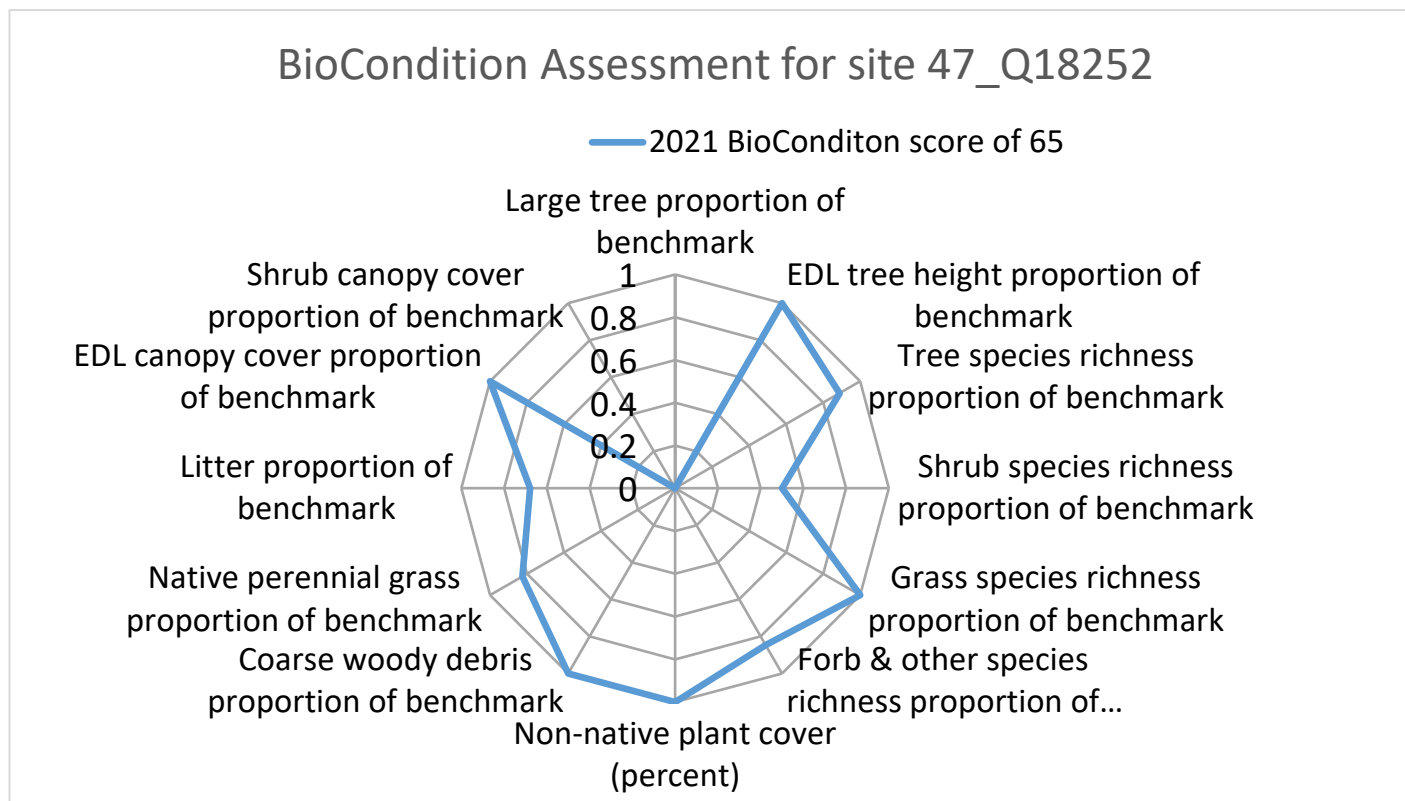


Figure 27. Radar diagram showing components of the BioCondition score for Site 47 (Q18252)



The canopy of site 47 meets the benchmark for height and cover, but there were no large trees present, which is the primary reason for the BioCondition score of 65 (Figure 27). The fire killed all the shrubs and low trees and ground layer is now very sparse with scattered perennial grasses and the vine *Cissus hypoglauca*.

Figure 28. Site 47 (Q18252) *Corymbia intermedia*, *Lophostemon confertus* open forest.

Site 49 (Q18280) Burnt *Corymbia intermedia*, *Banksia aemula* woodland.

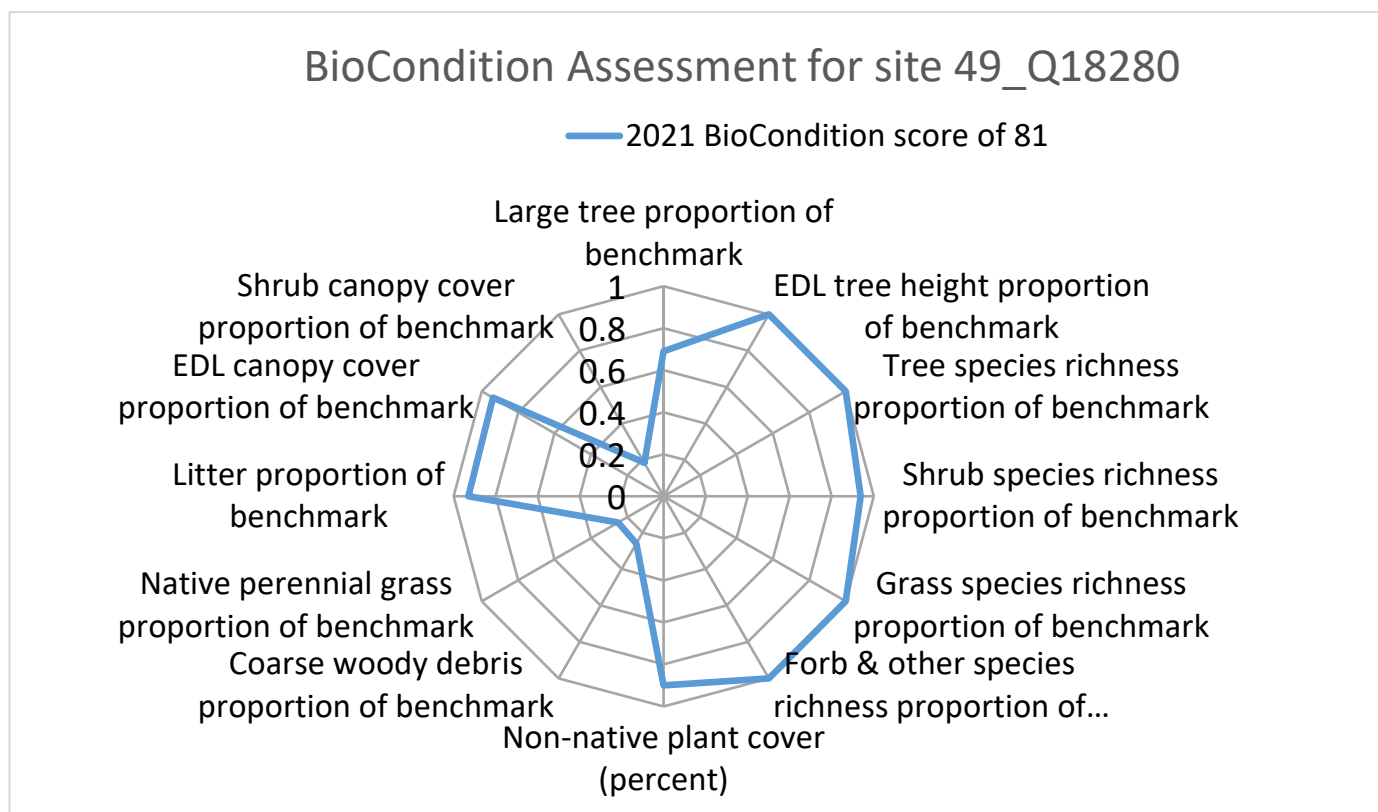


Figure 29. Radar diagram showing components of the BioCondition score for Site 49 (Q18280).



Site 49 had a BioCondition score of 81 (Figure 29) and was located in a dune swale. It has *Melaleuca quinquenervia* and *Lophostemon suaveolens* as subdominant species in the canopy with the dominant being *Corymbia intermedia* (Figure 30). *Banksia aemula* dominates the sparse subcanopy layer. The BioCondition score was lower than the benchmark for perennial grass cover, shrub cover and coarse woody debris. The ground layer was dominated by *Pteridium esculentum* and *Dianella caerulea*

Figure 30. Site 49 (Q18280) Burnt *Corymbia intermedia*, *Banksia aemula* woodland.

Regional Ecosystem 12.2.7 *Melaleuca quinquenervia* open forest on sand plains

This RE is widespread in coastal SEQ bioregion with a remnant extent in 2019 of 19000 hectares. The fire management guidelines suggest a variety of fire regimes may be used to maintain the different structures and communities within this RE (Queensland Herbarium 2020).

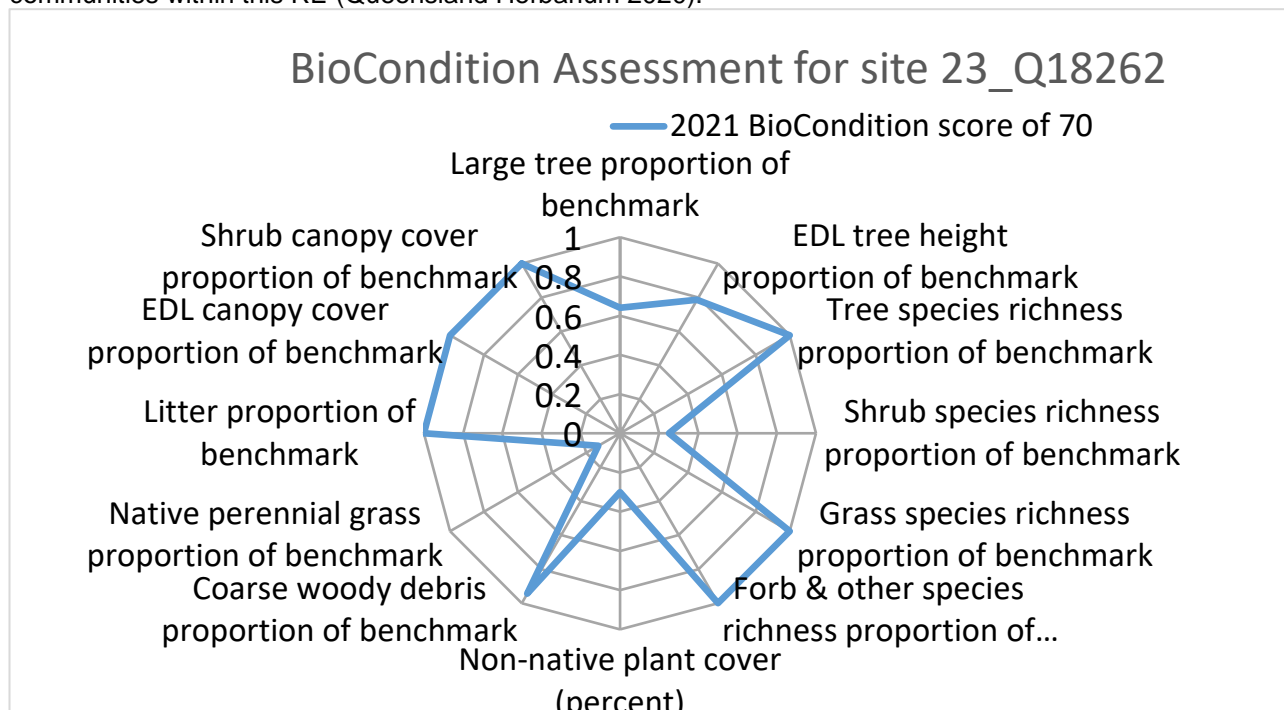


Figure 31. Radar diagram showing components of the BioCondition score for Site 23 (Q18262).



Site 23 had emergent *Eucalyptus tereticornis* and *Corymbia intermedia*. The BioCondition score was 70 (Figure 31) and was reduced because of a high (38%) cover of *Lantana camara* in the shrub layer, and 8% cover of *Passiflora pallida* in the ground layer (Figure 32). The cover of these weeds has probably reduced the shrub species richness and perennial grass cover. The site has a lower canopy and less large trees than the benchmark.

Figure 32. Site 23 (Q18262) *Melaleuca quinquenervia* open forest with *Lantana*

camara shrubs

Regional Ecosystem 12.2.8. *Eucalyptus pilularis* open forest on high dunes

Site 30 (Q18259) *Eucalyptus pilularis* tall open forest with *Syncarpia hillii* and *Lophostemon confertus*

This RE has a remnant extent in 2019 of 22000 hectares with the largest distribution occurring on Fraser Island. The fire management guidelines suggest that low to moderate intensity fires in summer to winter are ideal to maintain the RE structure with a minimum fire interval of 4-8 years for a grassy system and 8-20 years for shrubby elements of the understorey (Queensland Herbarium 2020).

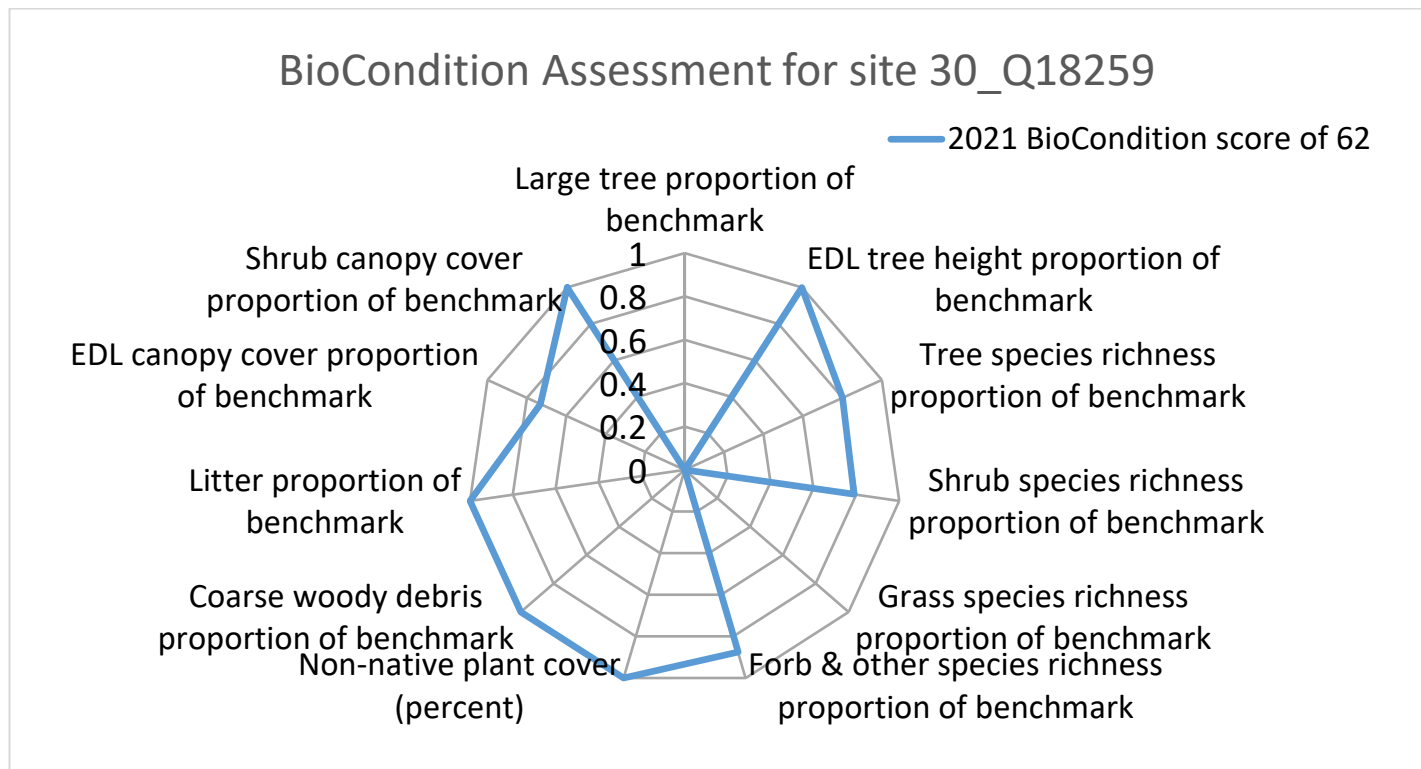


Figure 33. Radar diagram showing components of the BioCondition score for Site 30 (Q18259).



subcanopy at Site 30.

This site 30 has not been recently burnt and had a BioCondition score of 62 (Figure 33). It is dominated by *Eucalyptus pilularis* with *Syncarpia hillii* and *Lophostemon confertus* in the subcanopy and has two dense shrub layers (Figure 34). The upper shrub layer is dominated by *Dodonaea viscosa* subsp. *burmanniana* and *Phebalium woombye* and the lower shrub layer by *Macrozamia douglasii*. Its BioCondition score is significantly reduced by the lack of large trees (from previous logging) and lack of grass species.

Figure 35. *Eucalyptus pilularis* tall open forest with *Syncarpia hillii* and *Lophostemon confertus*

Site 32 (Q18258) *Eucalyptus pilularis* open forest. Burnt October 2020.

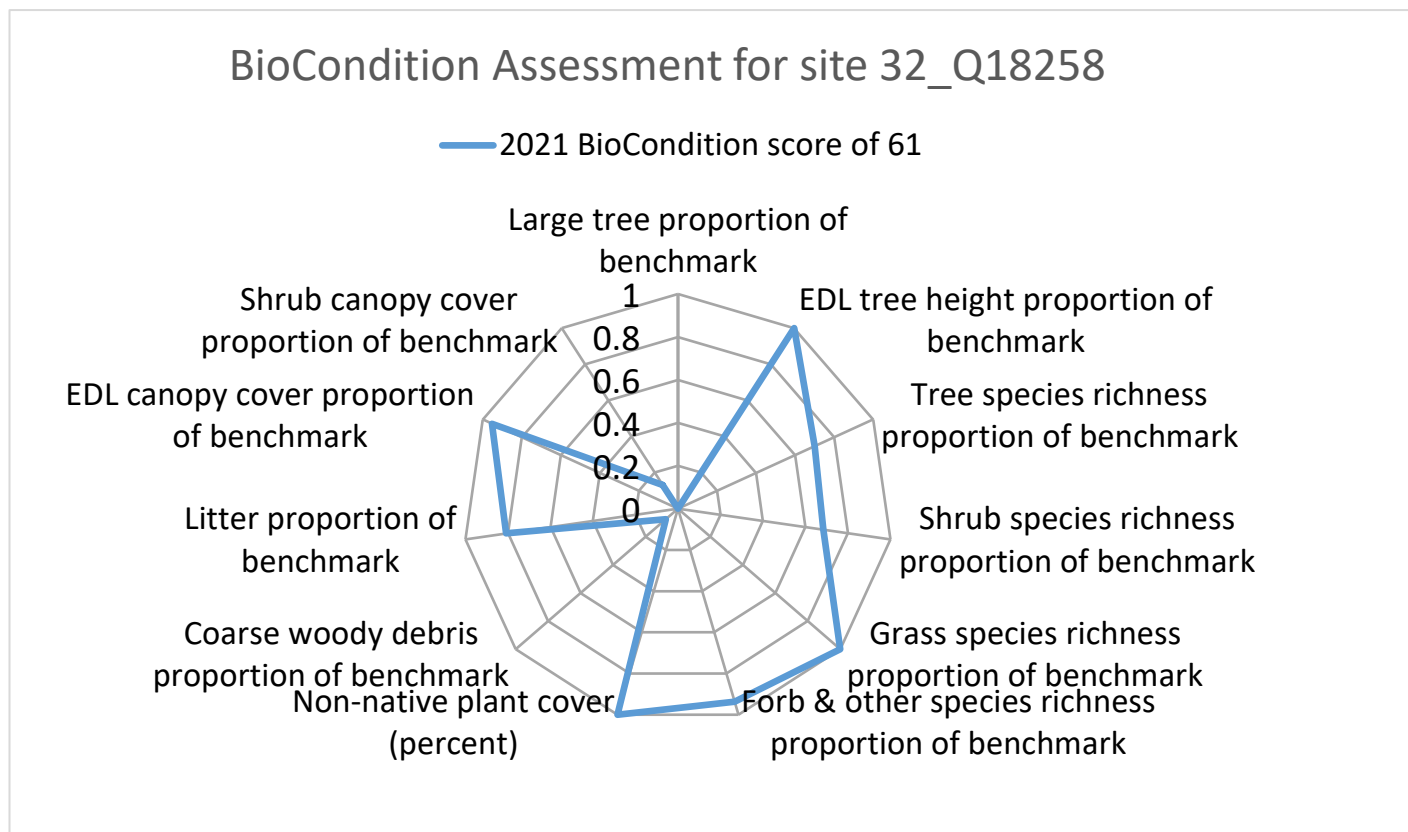


Figure 36. Radar diagram showing components of the BioCondition score for Site 32 (Q18258).



Site 32 had a BioCondition score of 61 (Figure 36). The BioCondition score is reduced because of the lack of large trees relative to the Benchmark as a consequence of logging, and the reduced shrub and coarse woody debris which may be due to the recent fire.

Fire in October 2020 (Figure 37) killed many T3 *Monotoca* sp. (Fraser Island) and, *Allocasuarina torulosa* trees (Figure 37). Patches of ground were covered with *Cissus hypoglauca* or *Smilax australis*.

Figure 37. Burnt *Eucalyptus pilularis* open forest at Site 32 (Q18258).

Site 18 (Q18258). Disturbed *Eucalyptus pilularis*, *Syncarpia hillii* woodland with dense cover of *Acacia penninervis* var. *longiracemosa* shrubs.

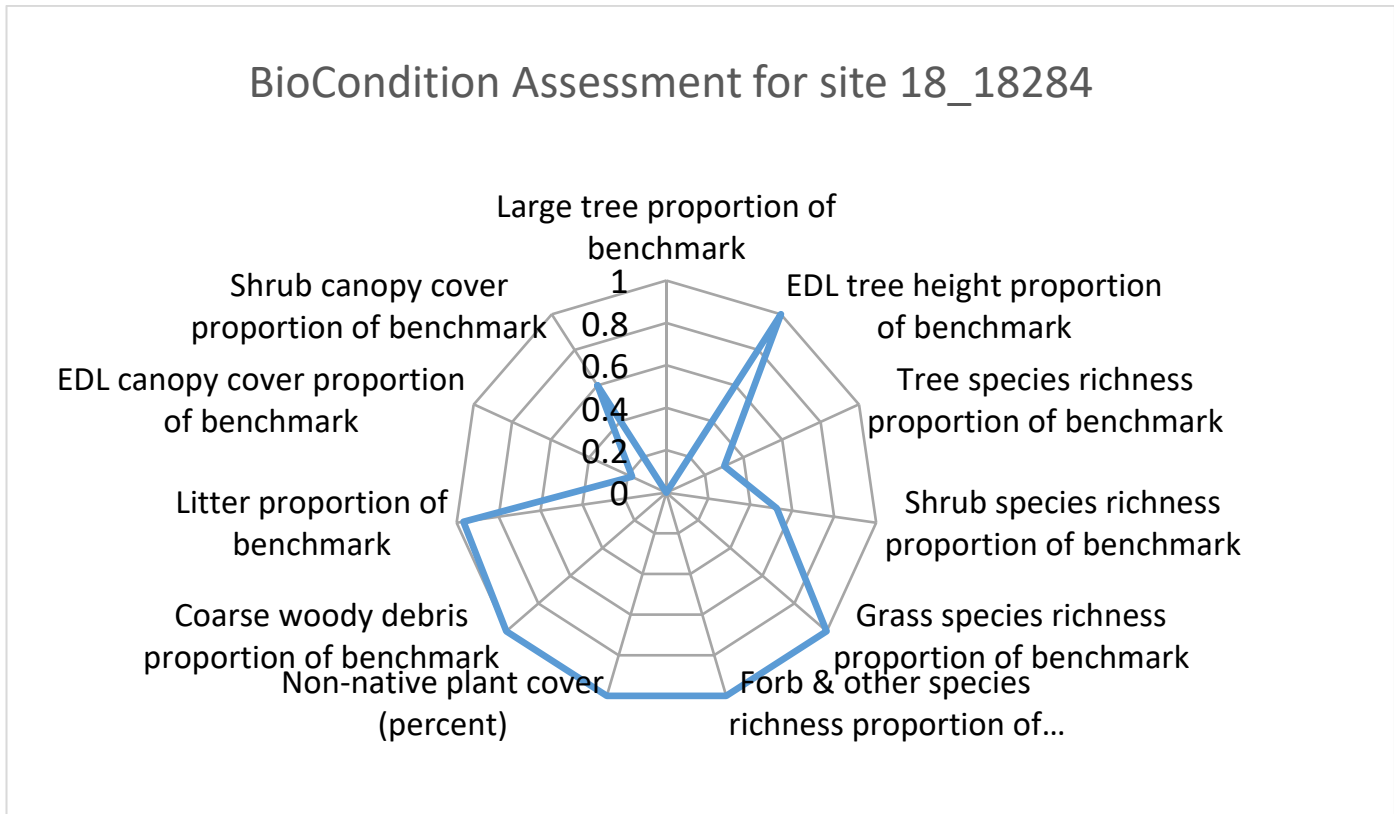


Figure 38. Radar diagram showing components of the BioCondition score for Site 18 (Q18284)



Site 18 had a BioCondition score of 78 (Figure 38). This disturbed *Eucalyptus pilularis*, *Syncarpia hillii* woodland (Figure 39) lacks the canopy cover, tree species richness and large trees expected in this RE (a legacy from logging management). It has a dense (100%) shrub cover dominated by *Acacia penninervis* var. *longiracemosa* 2.7m tall. The dense shrub layer has grown in response to intense fire in November 2019.

Figure 39. Disturbed *Eucalyptus pilularis*, *Syncarpia hillii* woodland with dense cover of *Acacia penninervis* var. *longiracemosa* shrubs

Regional Ecosystem 12.2.9. *Banksia aemula* low open woodland on dunes and sand plains.

Site 15 (Q18254) *Banksia aemula*, *Allocasuarina littoralis* low open woodland with heath shrub layer.

This RE has a remnant extent in 2019 of 57000 hectares covering areas on the SEQ islands and coast. The fire management guidelines suggest that moderate intensity fires in late summer to winter are ideal to maintain the RE structure with a minimum fire interval of 8-15 years (Queensland Herbarium 2020).

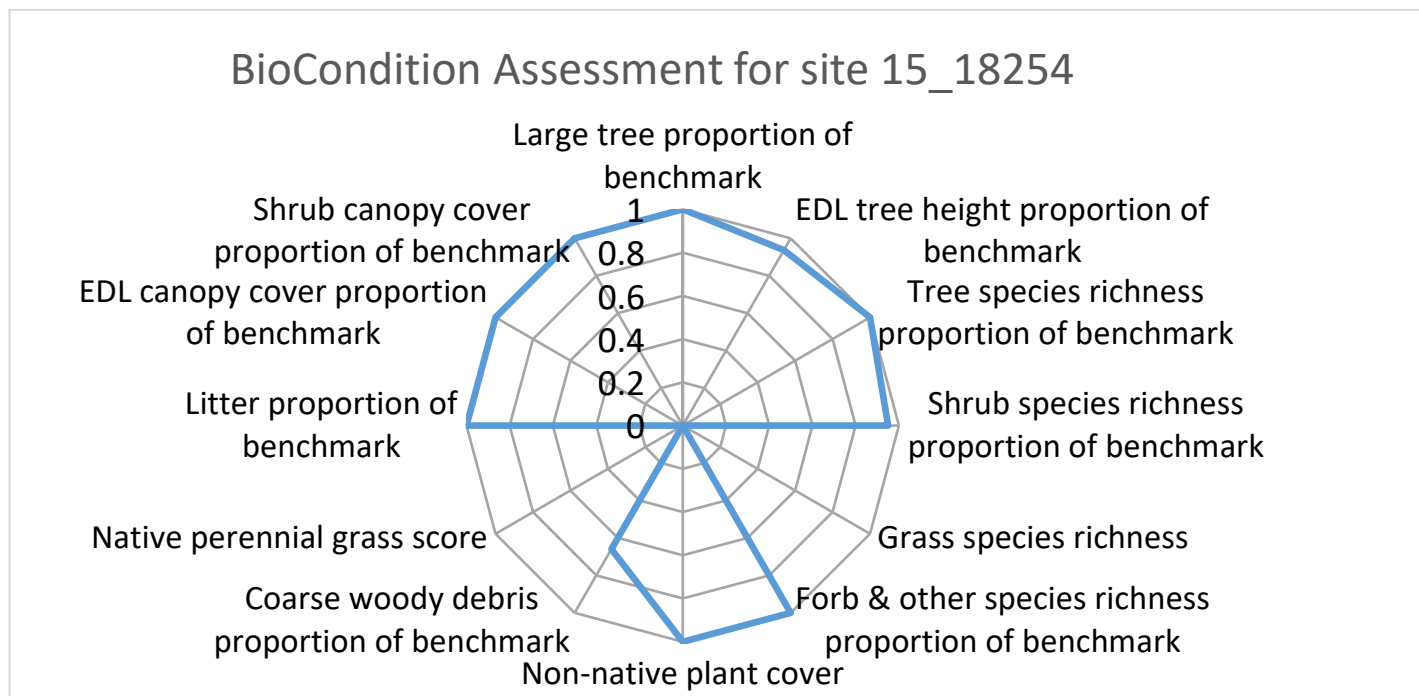


Figure 40. Radar diagram showing components of the BioCondition score for Site 15 (Q18254).



This site 15 was burnt in November 2019 however it has recovered to produce a high BioCondition score of 87 (Figure 40). It has a slightly lower canopy height and less coarse woody debris (a legacy from recent fire) than the benchmark (Figure 41).

Figure 41. Site 15 (Q18254) *Banksia aemula*, *Allocasuarina littoralis* low open woodland with shrub layer.

Site Deep Creek (Q18286) *Leptospermum semibaccatum*, *Banksia aemula* low open woodland with shrubby layer

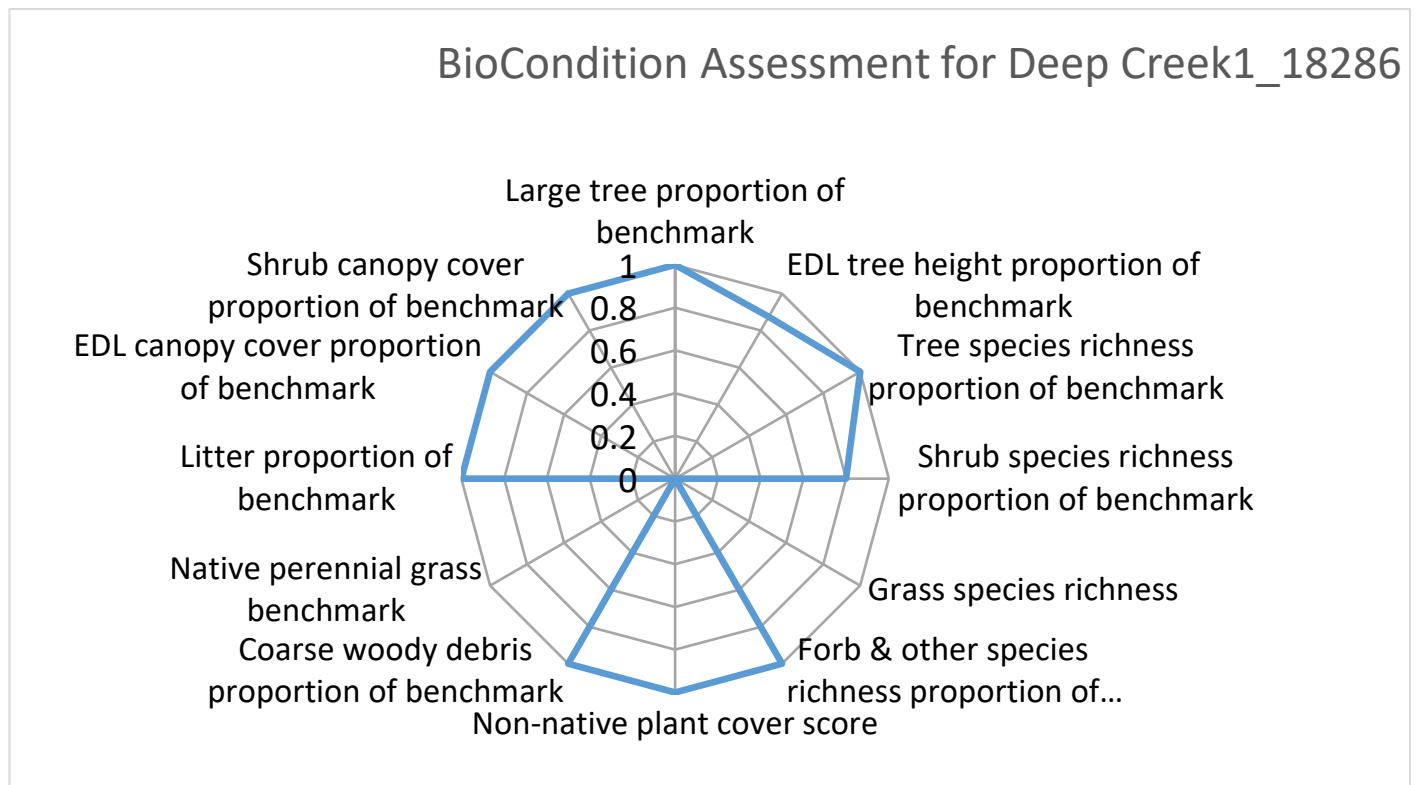


Figure 42. Radar diagram showing components of the BioCondition score for Site Deep Creek1 (Q18286).



This Deep Creek site was burnt in November 2019 however it has recovered to produce a high BioCondition score of 83 (Figure 42). The canopy is dominated by low trees of *Leptospermum semibaccatum* and *Banksia aemula*, and there are occasional emergent *Eucalyptus racemosa* (Figure 43). It has a slightly lower canopy height and lower shrub species richness than the benchmark.

Figure 43. Site Deep Creek (Q18286) *Leptospermum semibaccatum*, *Banksia aemula* low open woodland

Regional Ecosystem 12.2.11. *Corymbia tessellaris* +/- *Eucalyptus tereticornis*, *C. intermedia* and *Livistona decora* woodland on beach ridges

This RE has a remnant extent in 2019 of 21000 hectares with the largest distribution occurring on Northern SEQ coastal areas. The fire management guidelines suggest that this RE should not be burnt deliberately (Queensland Herbarium 2020) in narrow beach ridge situations. Where it occurs as a more extensive sandplain community, a low frequency of low severity fires may be appropriate.

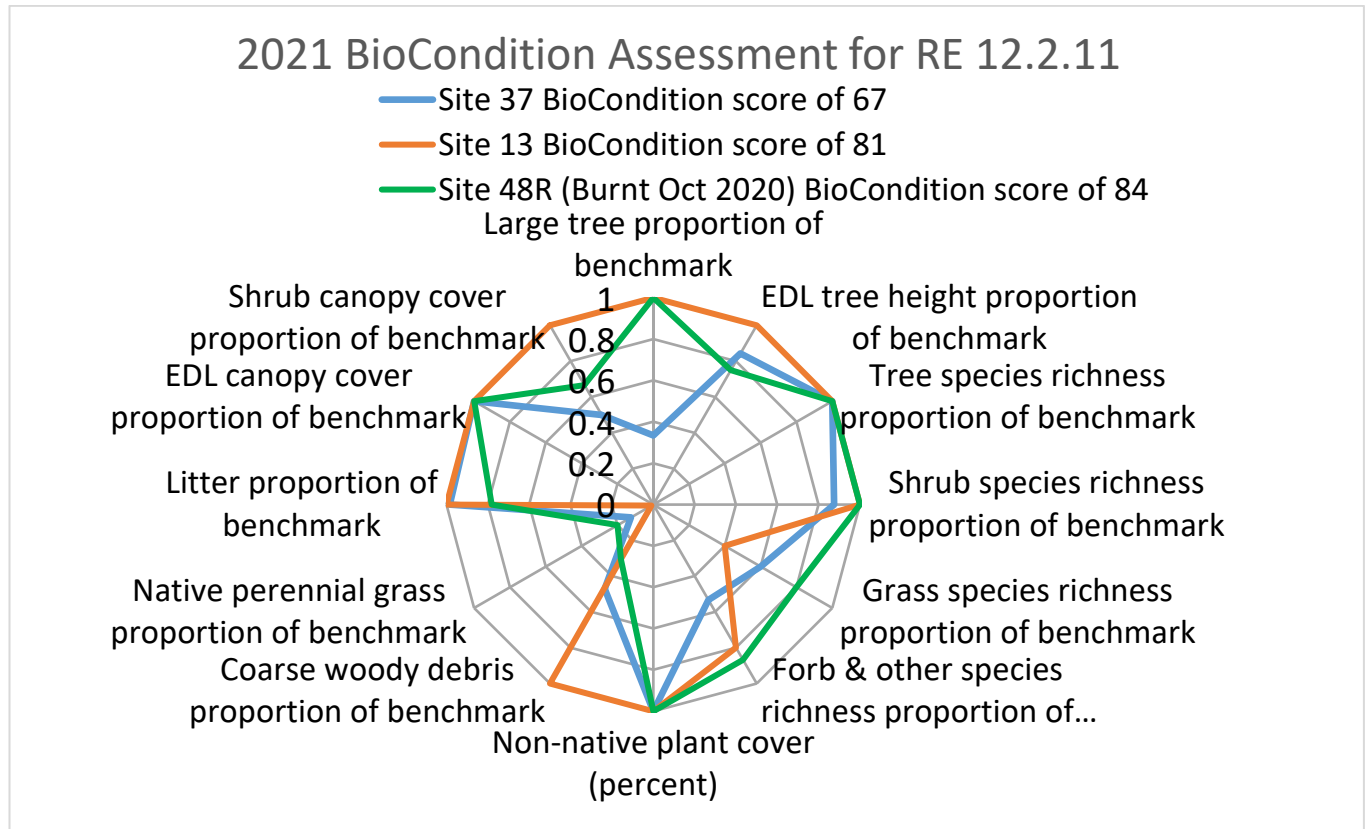


Figure 44. Radar diagram showing components of the BioCondition score for three sites: 13, 37 and 48R in RE12.2.11

Site 37 (Q18281) *Corymbia intermedia*, *Eucalyptus tereticornis* woodland.



This site, 37 (Q18281) had a BioCondition score of 67, caused by the lack of large trees, CWD, and grass and forb species. The site (Figure 45) had a moderate intensity fire that burnt and killed much of the T2 and T3 layer of *Allocasuarina littoralis* and *Acacia* spp. *Myrsine variabilis* was resprouting in the shrub layer.

Figure 45. Site 37 (Q18281) *Corymbia intermedia*, *Eucalyptus tereticornis* woodland.

Site 13 (Q18283) *Eucalyptus robusta*, *Melaleuca quinquenervia* with dense shrub layer



This site, 13, was located in an ecotone between 12.2.15 and 12.2.6. It is a poor fit for 12.2.11. The BioCondition score for the site was 81 (Figure 44) but it had a low species richness for native perennial grasses. A high intensity fire in November 2019 killed many of the subcanopy *Melaleuca quinquenervia* trees and scorched most of the T3 of *Elaeocarpus reticulatus* and *Endiandra sieberi* many of which are now resprouting at the base (Figure 46). These resprouts plus a high cover of *Dodonaea viscosa* subsp.

burmanniana and *Acacia flavescens* stimulated by the fire has led to a dense shrub layer.

Figure 46. Site 13 (Q18283) *Eucalyptus robusta*, *Melaleuca quinquenervia* with dense shrub layer of *Dodonaea viscosa* subsp. *burmanniana* and *Acacia flavescens*.

Site 48R (Q18282) *Corymbia intermedia*, *C. tessellaris* open forest



This site, 48R, experienced a low severity fire in 2020. It had a high BioCondition score of 84 (Figure 44), with a lower shrub cover, perennial grass cover and coarse woody debris than the benchmark (Figure 47).

Figure 47. Site 48R (Q18282) *Corymbia intermedia*, *C. tessellaris* open forest

Regional Ecosystem 12.2.14 Strand and fore dune complex

This RE has a remnant extent in 2019 of 22000 hectares covering areas on the SEQ islands and coast. It is a complex of a number of vegetation communities ranging from grasslands to open forests. The fire management guidelines suggest that this RE should not be burn deliberately (Queensland Herbarium 2020).

Site 3 (Q18247) *Corymbia tessellaris*, *C. intermedia* with *Acacia leiocalyx*, *A. disparrima* low open forest

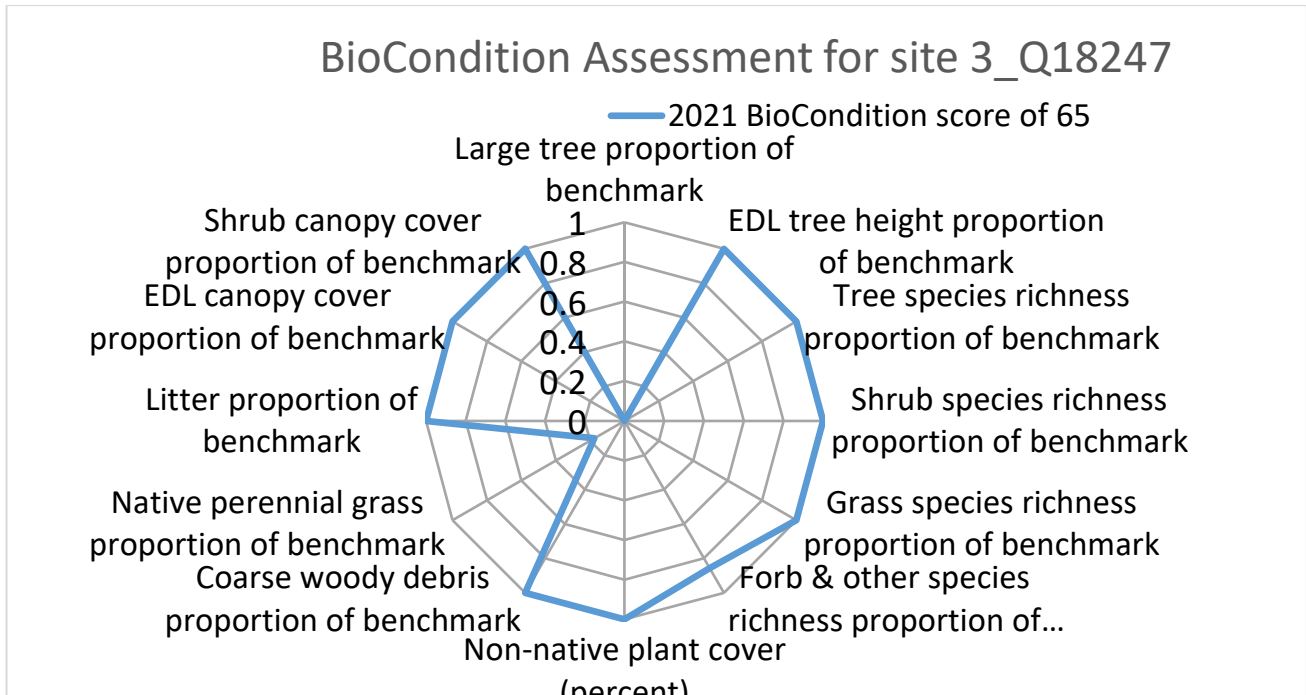


Figure 48. Radar diagram showing components of the BioCondition score for Site 3 (Q18247).



This site, 3, was only metres from the beach and relatively exposed to the sea breezes. It has a BioCondition score of 65 (Figure 48). It lacked large trees and coarse woody debris relative to the benchmark (Figure 49), and these attributes reduced its BioCondition score to 65.

Figure 49. *Corymbia tessellaris*, *C. intermedia* with *Acacia leiocalyx*, *A. disparrima* low open forest

Site 3 (Q18247).

Regional Ecosystem 12.2.14a: *Casuarina equisetifolia* subsp. *incana* woodland to low open forest. Exposed frontal areas

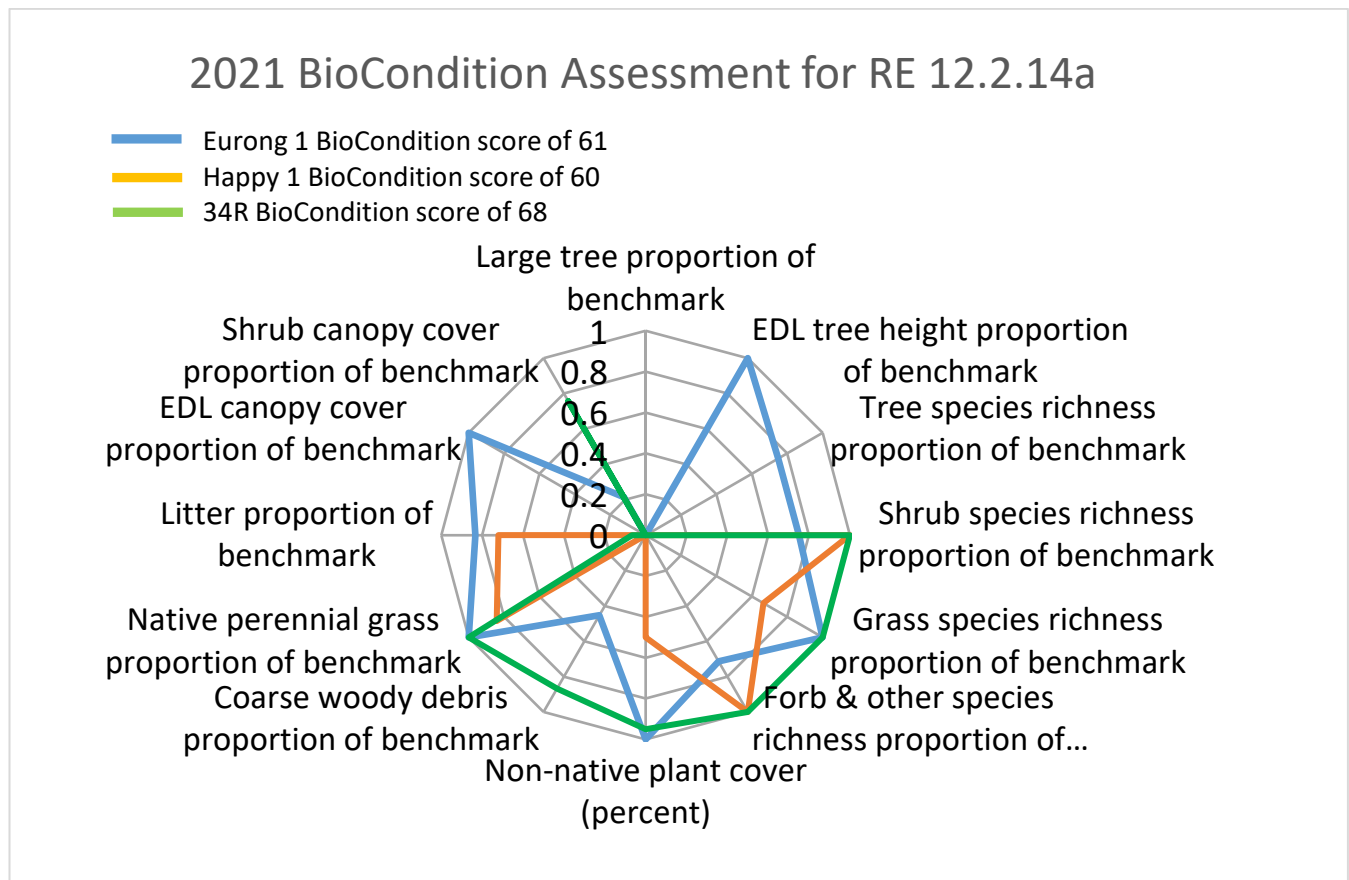


Figure 50. Radar diagram showing components of the BioCondition score for three sites in RE12.2.14a.

Site Eurong1 (Q18186) *Casuarina equisetifolia* subsp. *incana* low woodland.



This site, Eurong1, had a BioCondition score of 61 (Figure 50) and was on a beach ridge immediately adjacent the high tide mark (Figure 51). It only had a BioCondition score of 61 mainly because of the relatively young trees and there were no large trees or coarse woody debris and little shrub cover.

Figure 51 Site Eurong1 (Q18186) *Casuarina equisetifolia* subsp. *incana* low woodland

Site Happy1 (Q18226) Burnt *Casuarina equisetifolia* subsp. *incana* low woodland.



This site, Happy1, is located on a high dune 900 metres north of Happy Valley. The BioCondition score of 60 is reduced by the death of all the trees and lack of coarse woody debris (Figure 50). It experienced a high severity fire in 2020 which killed all of the canopy *Casuarina* trees (Figure 52). All shrubs were burnt but many are resprouting. There are no *Casuarina* seedlings present.

Figure 52. Site Happy (Q18226) Burnt *Casuarina equisetifolia* subsp. *incana* low woodland

Site 34R (Q18289) Burnt *Banksia integrifolia* low woodland (all dead).



This site had a BioCondition score of 68 (Figure 50) and is located 100 metres from the high side mark on the side of a dune. It experienced a high severity fire in 2020 which killed all of the canopy *Banksia* trees (Figure 53). All shrubs were burnt but many are resprouting. There are no *Banksia* seedlings present. The BioCondition score of 68 reflects the lack of living trees, coarse woody debris, shrub cover and nine percent cover of *Passiflora pallida* in the ground layer.

Figure 53. Site 34R (Q18289) Burnt *Banksia integrifolia* low woodland

Regional Ecosystem 12.2.15g *Gahnia sieberiana*, *Empodisma minus*, *Gleichenia* spp. closed sedgeland in coastal swamps

This regional ecosystem is naturally a closed sedgeland and generally does not support trees, but an open shrub layer of the woody sedge *Gahnia sieberiana* and/ or *Banksia robur* and/or *Leptospermum liversidgei* may be present. Hence the BioCondition score is calculated on the ground layer attributes. The four sites recorded in this RE, were all burnt in October 2020 and all recorded a similar BioCondition score with the amount of litter cover being the main difference. Its remnant extent in 2019 was 26000 ha. The fire management guidelines suggest that this RE should only be burnt when the swamps are wet to prevent the risk of peat fires (Queensland Herbarium 2020).

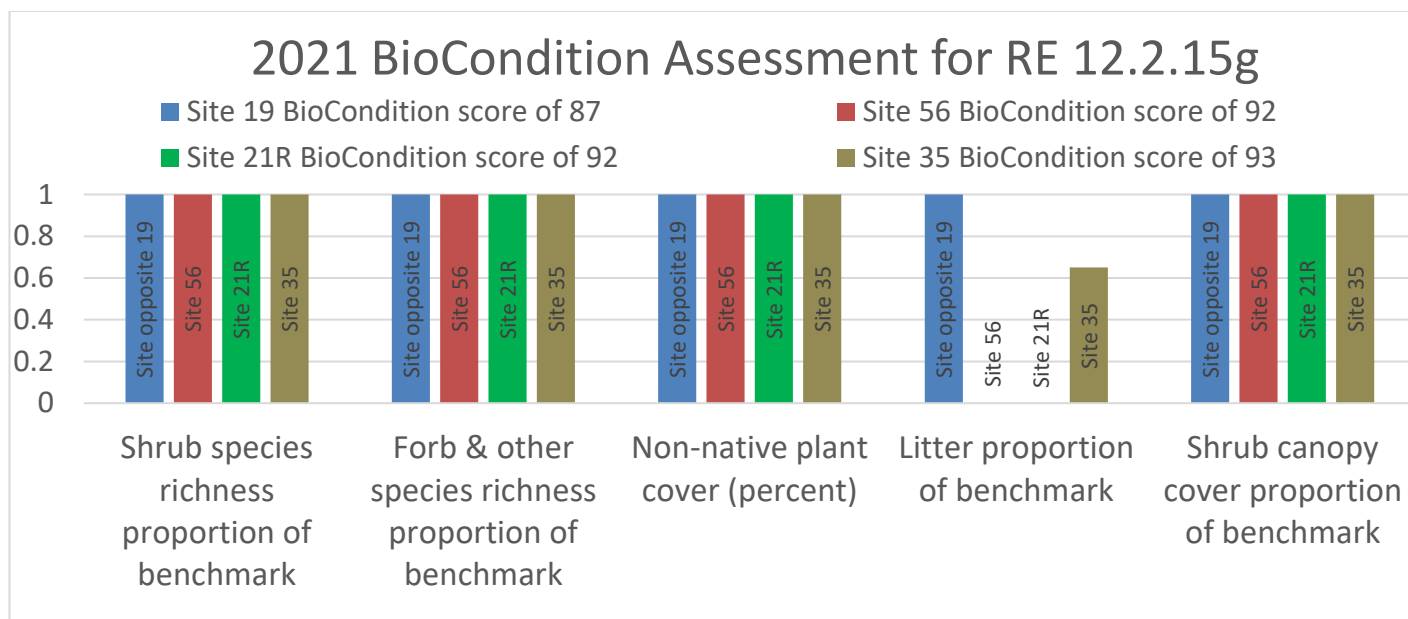


Figure 54. Bar graph of attribute scores for four sites in RE 12.2.15

Site 19 (Q18248) Burnt closed sedgeland of *Empodisma minus* with *Gahnia sieberiana*



This site, 19 (opposite the HH site 19), had a BioCondition score of 87 (Figure 54) and comprised of a burnt closed sedgeland dominated by *Empodisma minus* with *Gahnia sieberiana* in a dune swale drainage area. Some *Eucalyptus robusta* and *Melaleuca quinquenervia* emergent trees are resprouting after the fire (Figure 55).

Figure 55. Site 19 (Q18248) Burnt closed sedgeland dominated by *Empodisma minus* with *Gahnia sieberiana*

Site 56 (Q18288) *Empodisma minus* closed sedgeland



Site 56 had a BioCondition score of 92 (Figure 54).

This extensive swamp was dominated by *Empodisma minus* closed sedgeland with only the occasional shrub (Figure 56). It had recovered well after the October 2020 fire.

Figure 56. Site 56 (Q18288) *Empodisma minus* closed sedgeland

Site 21R (Q18290) Closed sedgeland with *Gahnia sieberiana*, *Leptospermum liversidgei* and *Banksia robur*.



Site 21R was on an extensive swamp and had a BioCondition score of 92. It was dominated by *Empodisma minus* and *Gleichenia spp.* closed sedgeland with significant areas having a mid-dense shrub layer of *Banksia robur*, *Gahnia sieberiana* and *Leptospermum liversidgei* (Figure 57). It had recovered well after the October 2020 fire.

Figure 57. Site 21R (Q18290) Closed sedgeland with *Gahnia sieberiana*, *Leptospermum*

liversidgei and *Banksia robur*.

Site 35 (Q18291) Closed sedgeland of *Empodisma minus*, *Gleichenia* spp. with *Banksia robur* shrubs



Site 35 had a BioCondition score of 93 (Figure 54). This closed sedgeland dominated by *Gleichenia* spp. and *Empodisma minus* has recovered well from the October 2020 fire (

Figure 58). Burnt *Banksia robur* and *Gahnia sieberana* shrubs were resprouting, as were the *Eucalyptus robusta* trees at the margin of the swamp.

Figure 58. Site 35 (Q18291) *Empodisma minus*, *Gleichenia* spp. closed sedgeland

The *Empodisma minus*-dominated sedgelands appear to be well adapted to burning, with fires not altering the representation of Restionaceae over the last 12 000 years at Moon Point (Moss et al. 2015). There appear to have been an increase in the myrtaceous shrubs *Melaleuca* and *Leptospermum* at Moon Point sedgeland as a result of less frequent fires after European settlement. Further research is necessary to understand whether vegetation thickening is a threat to the conservation values of the *E. minus*-dominated sedgelands (Moss et al. 2015).

Discussion

The establishment of QBEIS sites, using historic monitoring sites where possible, will enable assessment of changes through time in the past and future (not the purpose of this report). In this report, the BioCondition tool has been used to assess the condition of the nine regional ecosystems for which a QBEIS monitoring site was established on K'gari (Fraser Island) in 2021, and to gauge the impact of the 2019 and 2020 fires on the vegetation. As stated in the methods section, BioCondition uses ten attributes to compare to the Benchmark attribute scores to produce an overall BioCondition score. All attributes of non-native plant cover and number of large trees have a higher weighting than the other attributes. Hence the lack of large trees, which is not an impact of the recent fires but potentially from past fire regimes and/or previous logging, can have a significant influence on the BioCondition score. Naturally non-woody REs e.g. 12.2.15g use less attributes in the BioCondition assessment and have been standardised to the maximum score of 100, so the influence of each individual attribute used is increased.

Fire is a regular ecological occurrence for all of the REs assessed however the frequency and intensity of fires can have different effects on the vegetation. The typical fire scenarios thought to be ideal to maintain REs has been summarised in the fire guideline in the Regional Ecosystem Description Database (REDD) (Queensland Herbarium 2021). Some REs may have a different ground and shrub structure in different locations e.g. RE 12.2.6, and the fire regimes recommended to maintain such communities may be different.

There were definitely a large number of individual trees and shrubs killed in the November 2019 and October to December 2020 fires. As expected, this tree death was generally higher where the fires were more severe (Table 1) and susceptibility varied with species.

While most plants within the sampled REs appear to be able to resprout vegetatively after fire, there are also a number that are killed outright by fire and rely of seed germination to replace lost individuals. Resprouting was evident at all the 22 burnt sites assessed, and there were some examples of dense seedling recruitment in various sites e.g. *Eucalyptus pilularis* in RE12.2.4, *Acacia penninervis* subsp. *longiracemosa* and *Dodonaea viscosa* subsp. *burmanniana* in 12.2.8. However there was a distinct lack of recruitment of *Casuarina equisetifolia* subsp. *incana* (site Happy) and *Banksia integrifolia* (site 34R) in RE12.2.14a. This lack of recruitment in these exposed foredune communities was the most concerning impact of the 2020 fire. There were good follow-up rains after the fire so it appears that both the seed store held on the mature trees and that in the soil seed bank may have been destroyed by the fire. This needs further investigation but if found to be true then intervention through rehabilitation plantings of the canopy species may be urgently required.

The tree and shrub cover at most burnt sites will take a number of years to recover to benchmark values. However for most sites the floristic diversity across life form groups – trees, shrubs, grasses and forbs – appear to have returned after fire. Most sites sampled were relatively undisturbed and consequently mainly weed free. The exceptions to this were Site 23 with a significant *Lantana camara* shrub layer, and *Passiflora pallida* occurring the ground layer in six sites. However weed infestations were noted outside of sites in disturbed situations and near roadsides, particularly in the formerly sand mined areas in the south. One seedling of *Baccharis halimifolia* was recorded on site Cornwall2 but no adult plants were noted.

Conclusion and recommendations

On the basis of a single sampling it is difficult to make firm conclusions on the trajectory of the vegetation in its recovery from the 2019 and 2020 fires. However for all of the 19 Hockings/ Hobson sites that were resampled, the current vegetation appears to contain a similar species composition to that recorded from 1995 onwards. The overall conclusions made independently to that of Meiklejohn *et al.* (2021) but consistent with that study are that robust recovery is occurring across all of the nine REs sampled, apart from the coastal *Casuarina equisetifolia* woodlands and *Banksia integrifolia* woodlands on the frontal beach ridges and high dunes. The lack of regeneration of the dominant tree species in these areas is the major concern.

Recommendation 1. Further sampling and monitoring occur immediately throughout the burnt RE12.2.14a (*Casuarina equisetifolia* subsp. *incana* woodland to low open forest; exposed frontal areas) to determine if the impacts recorded by this study occur throughout the burnt area, particularly north of Happy Valley township. If this is the case, then some rehabilitation planting of *Casuarina equisetifolia* and *Banksia integrifolia* should occur to stabilise these dunes for the future. The vegetation community RE12.2.14c *Casuarina equisetifolia* subsp. *incana* open forest with *Pandanus tectorius* sub-canopy was not sampled in this study, but has been similarly severely impacted by the 2020 bushfire (Meiklejohn *et al.* 2021).

Recommendation 2. Maintain the QBEIS monitoring program with an interval of no longer than five years between re-sampling. The trend in recovery can only be tracked with further resampling. This will provide robust data to assist with fire management decisions in the future.

Recommendation 3. Maintain vigilant reconnaissance for weed invasions and react quickly to new infestations. The successful removal of Bitou bush required a 35-year period of strategic and collaborative annual survey and control effort (Behrendorff *et al.* 2019). Vigilance is required because of the continuous potential source of new propagules given the capacity of birds as vectors and the high volume of vehicles to the island and townships.

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Appendix 1 Fraser Island Regional Ecosystem Benchmarks

Regional Ecosystem	Recruitment	Non-native_plant_cover	Tree_spp_richness	Shrub_spp_richness	Grass_spp_richness	Forb_and_other_spp_richness	Tree_canopy_height	Tree_subcanopy_height	Tree_canopy_cover	Tree_subcanopy_cover	Large tree threshold_Eucalypt	Large tree threshold_Non eucalypt	Total_num_large_trees_euc_ha	Tot_num_large_trees_non_euc_ha	Shrub_canopy_cover	Native_perennial_grass cover	Litter_ground_cov	Coarse woody debris_length_ha
12.2.4	100	0	25	15	na	24	30	10	96	70	66	42	29	12	25	na	0	278
12.2.5	100	0	5	10	3	14	16	6	80	20	43	35	33	45	14	12	70	577
12.2.6	100	0	9	16	2	13	16	na	64	na	53	28	34	24	26	4	71	138
12.2.7	100	0	3	4	3	12	14	8	60	20	50	30	5	120	15	15	30	900
12.2.8	100	0	10	19	1	16	22	na	83	na	67	31	29	28	26	na	86	540
12.2.9	100	0	3	15	1	10	6	na	26	na	48	14	12	17	19	3	47	6
12.2.11	100	0	9	8	5	15	16	8	48	20	42	30	28	32	12	20	63	599
12.2.14	100	0	4	4	3	7	6	na	42	na	na	22	na	22	14	12	30	53
12.2.15	100	0	na	1	na	6	na	na	na	na	na	na	na	na	4	na	4	na

Appendix 2. Table of monitoring site locations

Site ID	Pickets located	Burnt 2020	Photo April 2021	Comment	QBEIS ID	Vegetation summary	RE at site	Easting (origin)	Northing (origin)
HH_1	No	No	No	Searched for and not located based on GPS, old road not used nearby					
HH_3	yes	No	yes	Relocated and photographed and resampled	18247	<i>Corymbia tessellaris</i> , <i>C. intermedia</i> with <i>Acacia leiocalyx</i> , <i>A. disparrima</i> low open forest	12.2.14	509209	7168929
HH_5	No	No	No	Searched for and not located based on GPS, road description does not match					
HH_6	yes	No	yes	Relocated and photographed, but not resampled. Inundated with 30-60cms of water		<i>Melaleuca quinquenervia</i> open forest in standing water 30-60cm deep. 80% of trees are alive 14-16 m tall. BA of 40m ² /ha. Fire scars to 8 m. One <i>Lophostemon suaveolens</i> resprouting.	12.2.7	507453	7157729
HH_10	No	No	No	Searched for and not located based on GPS or conflicting road description location					
HH_11	yes	No	yes	Relocated on the basis of distance from Boomanjin and photographed and resampled	18285	<i>Eucalyptus racemosa</i> , <i>Syncarpia hillii</i> shrubby woodland. Site not burnt in last 2 or more years.	12.2.6	506204	7171664
HH_12	No	No	No	Searched for and not located based on GPS					
HH_13	yes	No	yes	Relocated and photographed and resampled	18283	An ecotone. <i>Eucalyptus robusta</i> , <i>Melaleuca quinquenervia</i> with dense shrub layer of <i>Dodonaea viscosa</i> and <i>Acacia flavescens</i> . Hot fire killed T2.	12.2.11	497975	7169993

Site ID	Pickets located	Burnt 2020	Photo April 2021	Comment	QBEIS ID	Vegetation summary	RE at site	Easting (origin)	Northing (origin)
HH_14	no	no	no	Post there, but could not relocate pickets in dense Monotoca understorey					
HH_15	yes	no	yes	Relocated and photographed and resampled	18254	<i>Banksia aemula</i> , <i>Allocasuarina littoralis</i> low open woodland with heath/shrub layer	12.2.9	503490	7168263
HH_17	yes	no	yes	Relocated and photographed, but not resampled.		Vine forest with <i>Syncarpia hillii</i>	12.2.4		
HH_18	yes	no	yes	Relocated and photographed and resampled	18284	Very disturbed <i>E. pilularis</i> , <i>Syncarpia hillii</i> woodland with 100% cover of tall <i>Acacia penninervis</i> shrubs	12.2.8	500956	7175435
HH_19	No	yes	No	Searched for and not located based on GPS, new site installed in swamp across the road	18248	Burnt closed sedgeland with <i>Gahnia sieberiana</i> . Picket 5m from road. 13.2m 60 degrees east to origin.	12.2.15	508677	7194799
HH_21	No	no	No	Searched for and not located based on GPS, new site installed at site	18290	Closed sedgeland with <i>Gahnia sieberiana</i> and <i>Banksia robur</i>	12.2.15	506936	7196750
HH_22	yes	no	yes	Relocated and photographed and resampled	18261	<i>Corymbia intermedia</i> , <i>Eucalyptus racemosa</i> open forest	12.2.6	511522	7179116
HH_23	No	no	Yes	Searched for and not located based on GPS, new site installed at site	18262	<i>Melaleuca quinquenervia</i> open forest with <i>Lantana camara</i> shrubs	12.2.7	499035	7185208
HH_24	Yes	no	Yes	Searched for and not located based on GPS, new site installed at site	18263	Hot fire maybe years previously. Blackened trunks to 4-5m <i>Banksia</i> , <i>Corymbia gummifera</i> . Resprout white trunk <i>Lophostemon suaveolens</i>	12.2.6	503554	7182015
HH_25	yes	no	yes	Relocated and photographed but not resampled, sound bar location		Closed sedgeland with <i>Gahnia sieberiana</i> and <i>Banksia robur</i>	12.2.15		

Site ID	Pickets located	Burnt 2020	Photo April 2021	Comment	QBEIS ID	Vegetation summary	RE at site	Easting (origin)	Northing (origin)
HH_26	No	no	No	Searched for and not located based on GPS or road description location e.g. Cornwells Break					
HH_28	No	no	No	Searched for and not located based on incorrect GPS or conflicting road description location e.g. Cornwells Break					
HH_29	No	no	No	Searched for and not located based on GPS, new site installed at site, Pile Valley	18287	<i>Syncarpia hillii</i> , <i>Lophostemon confertus</i> tall open forest	12.2.4	507241	7182581
HH_30	yes	no	yes	Relocated and photographed and resampled	18259	<i>Eucalyptus pilularis</i> tall open forest with <i>Syncarpia hillii</i> and <i>Lophostemon confertus</i> subcanopy and two dense shrub layers. <i>Dodonaea viscosa</i> / <i>Monotoca</i> / <i>Phebalium</i> S1 and <i>Macrozamia miquelii</i> , <i>Xanthorrhoea</i> S2	12.2.8	506634	7185364
HH_31	No		No	Searched for and not located based on GPS and road description					
HH_32	yes	yes	yes	Relocated and photographed and resampled	18258	<i>Eucalyptus pilularis</i> open forest. Burnt October 2020. Fire killed many T3, <i>Monotoca</i> spa, <i>Allocasuarina torulosa</i> . Ground covered with <i>Cissus hypoglauca</i> or <i>Smilax australis</i> .	12.2.8	525258	7216319
HH_33	yes	yes	yes	Relocated and photographed and resampled	18256	Severely burnt <i>Eucalyptus racemosa</i> , <i>Banksia aemula</i> woodland. Hot fire October 2020	12.2.6	516516	7220278

Site ID	Pickets located	Burnt 2020	Photo April 2021	Comment	QBEIS ID	Vegetation summary	RE at site	Easting (origin)	Northing (origin)
HH_34	No	yes	No	Searched for and not located based on GPS, new site installed just south at Bowrady Break	18289	Burnt <i>Banksia integrifolia</i> low woodland (all dead). Some shrubs resprouting. <i>Acacia leiocalyx</i> recruitment. Ground cover vines and <i>Ischaemum</i>	12.2.14a	527505	7213768
HH_35	yes	yes	yes	Relocated and photographed and resampled	18291	Swamp. Sedgeland	12.2.15	516570	7220252
HH_36	No	yes	No	Searched for and not located based on GPS, new site installed at site	18260	Burnt <i>Corymbia intermedia</i> , <i>E. pilularis</i> , <i>Lophostemon confertus</i> woodland	12.2.6	506793	7203378
HH_37	yes	yes	yes	Relocated and photographed and resampled	18281	<i>Corymbia intermedia</i> , <i>Eucalyptus tereticornis</i> woodland.	12.2.11	502305	7212742
HH_38	yes	yes	yes	Relocated and photographed and resampled	18255	<i>Corymbia intermedia</i> woodland with <i>Melaleuca quinquenervia</i> and <i>Lophostemon suaveolens</i>	12.2.5	503829	7212174
HH_39	yes	yes	yes	Relocated and photographed but not resampled		<i>Melaleuca quinquenervia</i> open forest	12.2.7		
HH_40	yes	yes	yes	Relocated and photographed but not resampled		<i>Corymbia intermedia</i> woodland with <i>Allocasuarina littoralis</i> subcanopy	12.2.6		
HH_41	yes	yes	yes	Relocated and photographed but not resampled		<i>Empodisma minus</i> closed sedgeland with <i>Banksia robur</i> low shrubs	12.2.15		
HH_42	yes	yes	yes	Relocated and photographed and resampled	18257	Burnt <i>Eucalyptus racemosa</i> , <i>Corymbia gummifera</i> woodland. Burnt in hot fire in October 2020. Fire burnt up to 8m on <i>C. gummifera</i> . Killed 1/3 T2, all S1.	12.2.6	519326	7221071
HH_43	yes	yes	yes	Relocated and photographed and resampled	18249	Burnt <i>Eucalyptus racemosa</i> , <i>Corymbia gummifera</i> low woodland	12.2.6	518368	7220393

Site ID	Pickets located	Burnt 2020	Photo April 2021	Comment	QBEIS ID	Vegetation summary	RE at site	Easting (origin)	Northing (origin)
HH_47	yes	yes	yes	Relocated and photographed and resampled, GPS reading erroneous	18252	<i>Corymbia intermedia</i> , <i>Lophostemon confertus</i> open forest. Dune swale. Burnt October 2020	12.2.6	526049	7215042
HH_48	No	yes	No	Searched for and not located based on GPS, new site installed at site	18282	<i>Corymbia intermedia</i> , <i>C. tessellaris</i> open forest	12.2.11	525171	7240527
HH_49	yes	yes	yes	Relocated and photographed and resampled	18280	Burnt <i>Corymbia intermedia</i> , <i>Banksia aemula</i> woodland	12.2.6	526992	7241659
HH_50	No	yes	No	Searched for and not located based on GPS,					
HH_54	No	yes	No	Searched for and not located based on GPS,					
HH_56	yes	yes	yes	Relocated and photographed and resampled, soundbar location	18222	Swamp - site with bird recorder. No trees. Closed Sedgeland.	12.2.15	524601	7241376
Cornwall 1		no	yes	Newly established site	18251	<i>Eucalyptus pilularis</i> , <i>Lophostemon confertus</i> , <i>Syncarpia hillii</i> tall open forest. No recent fire.	12.2.4	510038	7189734
Cornwall 2		yes	yes	Newly established site	18250	<i>Eucalyptus pilularis</i> , <i>Lophostemon confertus</i> , <i>Syncarpia hillii</i> tall open forest. Fire in October 2020 undergrowth and shrubs all burnt.	12.2.4	510093	7189784
Eurong 1		no	yes	Newly established site	18186	<i>Casuarina equisetifolia</i> low woodland. Foredune community; good condition	12.2.14a	512492	7177637
Happy 1		yes	yes	Newly established site	18226	Burnt <i>Casuarina equisetifolia</i> , <i>Banksia integrifolia</i> low woodland. All trees and shrubs killed by the fire. Some shrubs resprouting.	12.2.14a	520666	7198133
Deep Creek 1		no	yes	Newly established site	18286	<i>Leptospermum</i> spp., <i>Banksia aemula</i> low open woodland with shrubby layer	12.2.9	499493	7176791

Appendix 3. Photographs of monitoring sites that were relocated but not sampled in April 2021



HH6 *Melaleuca quinquenervia* open forest in waterlogged site. Most of the canopy burnt in 2019.



HH17 Logged *Syncarpia hillii*, *Lophostemon confertus* tall open forest site on Dillingham Road. Not burnt in recent years.



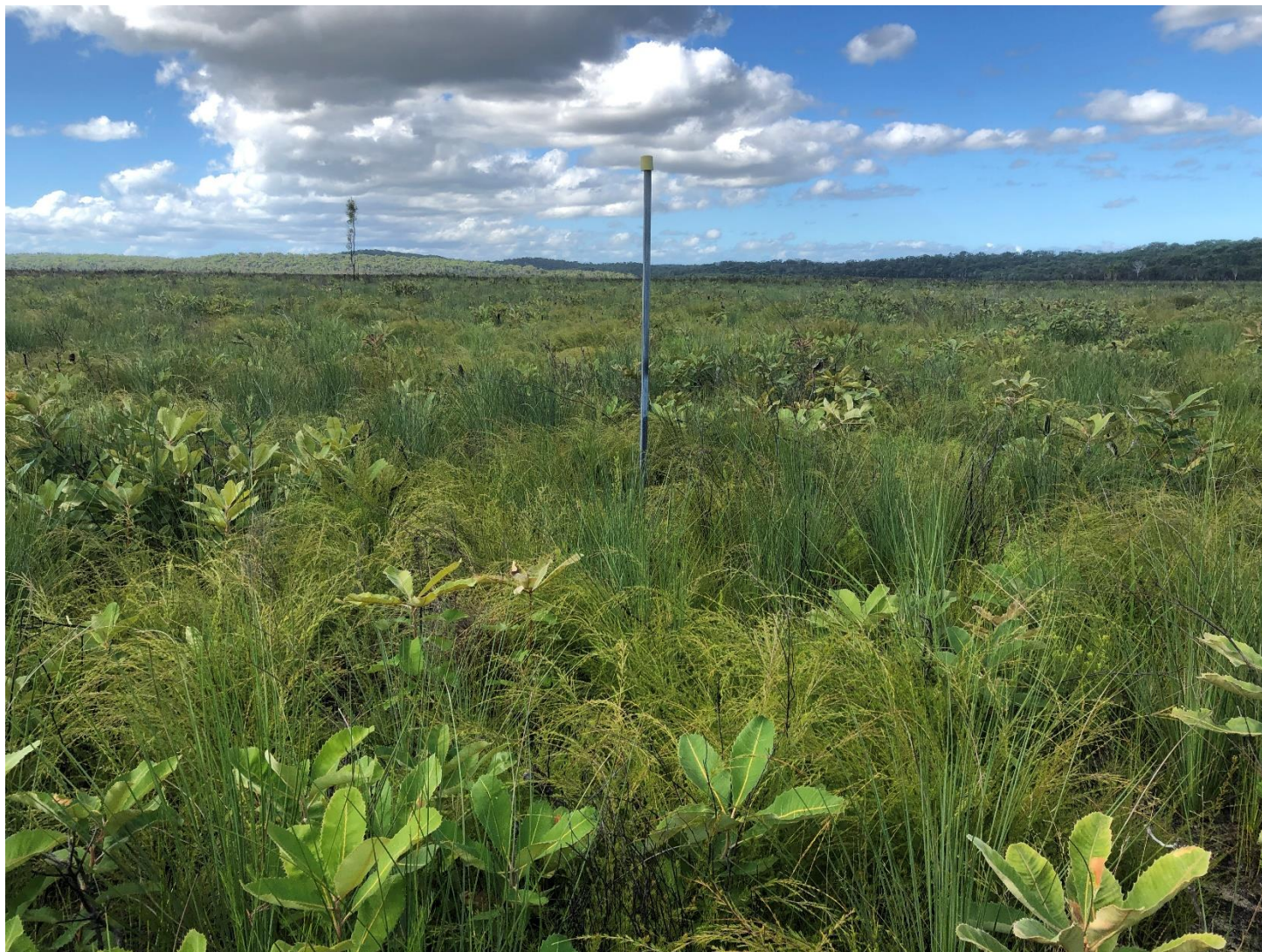
HH 25 *Empodisma minus* closed sedgeland. Not burnt in recent years.



HH 39 Inundated *Melaleuca quinquenervia* open forest. Burnt in 2020.



HH 40 *Corymbia intermedia* woodland with *Allocasuarina littoralis* subcanopy. Burnt in 2020.



HH 41 *Empodisma minus* closed sedgeland with *Banksia robur* low shrubs. Burnt in 2020.