

Technical information supporting South Australia's Land-Based Protected and Conserved Area Strategy

Summary of DEW approach and outputs | September 2024



Government
of South Australia

Department for
Environment and Water

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1. Summary and Background Context

The Department for Environment and Water (the department) and the Parks and Wilderness Council (the council) have developed a new *Land-Based Protected and Conserved Area Strategy* (the strategy) to drive meaningful action in expanding and enhancing protected and conserved areas over the next ten years.

The current document presents background information on biodiversity planning concepts and the analytical work that has been used to inform the Strategy.

2. Biodiversity and Conservation Planning

2.1 What Does the Biodiversity Concept Encompass?

Biodiversity is an abbreviation of biological-diversity and is a concept that encompasses the variety of life, its different levels of organisation and the associated ecological and evolutionary processes (Hunter, 2002).

2.1.1 The Variety of Life

The variety of life refers to all the different forms of life, including plants, invertebrate animals, fungi, bacteria and other micro-organisms, as well as vertebrate animals. Vertebrate animals and vascular plants are the most studied and described types of life. However, the most diverse in terms of numbers of different species are the arthropods (insects and spiders; May, 1992; Wilson, 1992; Figure 2.1.1).

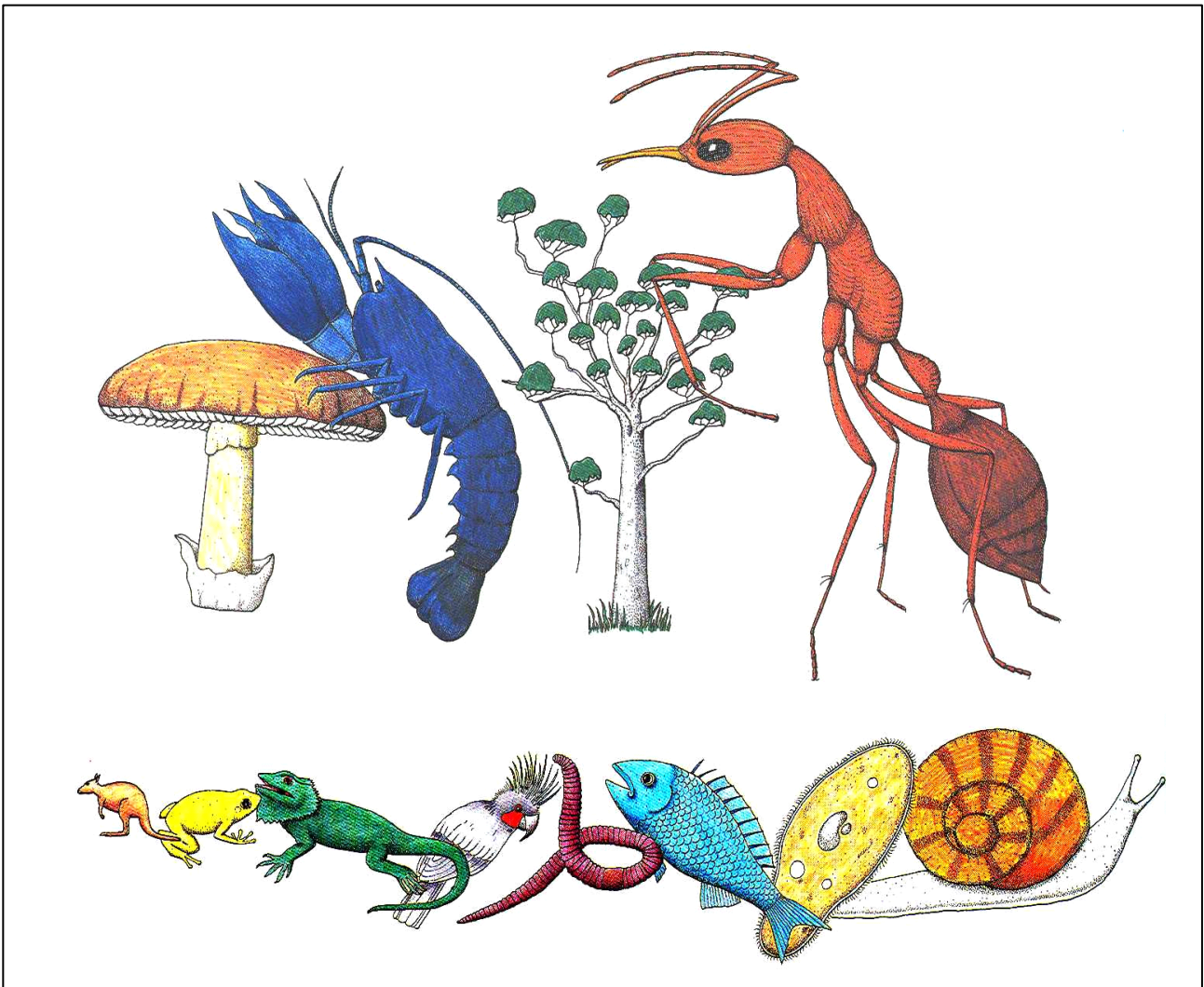


Figure 2.1.1: Diversity in Proportion

Relative numbers of species found within different forms of life represented by size.

Source: Beattie (1995). Biodiversity: Australia's Living Wealth, p.104-105.

2.1.2 The Organisation of Life

Life is organised at a number of different levels (Figure 2.1.2). The most tangible and familiar is the species level. However, genes shape the form and function of each individual organism, providing the basis through which species adapt to different environments and change through time (Hunter, 2002). So genetic diversity is also fundamentally important.

At the higher levels of organisation are ecosystems and landscapes. Ecosystems are a dynamic complex of interacting species and their physical environment, while landscapes are a mosaic of ecosystems (Calow, 1999; Hunter, 2002). At these levels, multiple species and associated processes may be conserved, including species that may be unknown to science (such as soil biota).

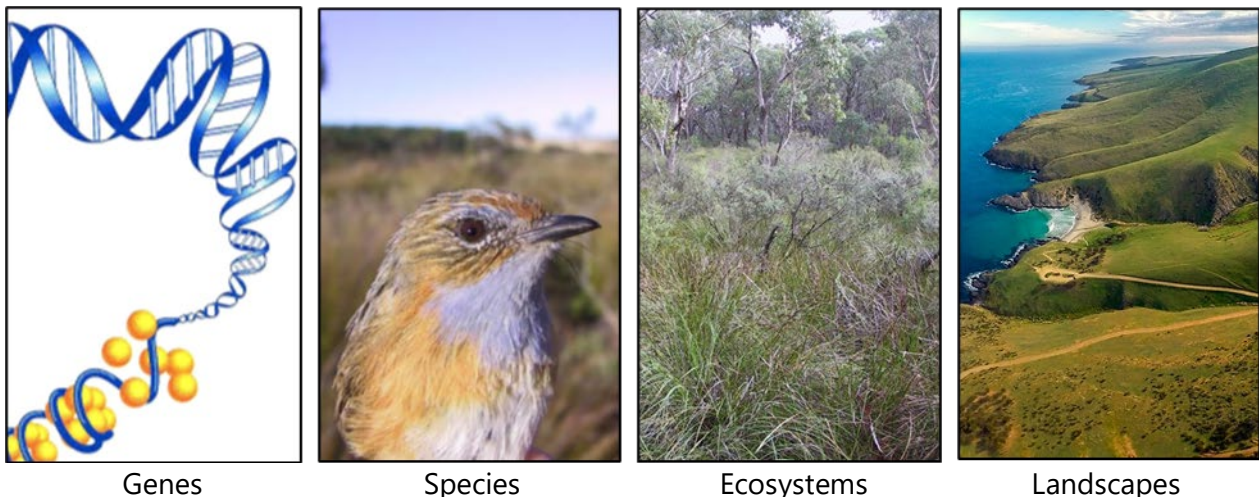


Figure 2.1.2: Levels of Organisation

Biodiversity is organised at a number of different levels: genetic, species, ecosystems and landscapes.

2.1.3 Ecological and Evolutionary Processes

Fundamental to the adaptation and maintenance of biodiversity are a series of ecological processes through which species interact with each-other, such as competition, predation, parasitism and mutualism (Morin, 1999). Species also interact with their physical environment through processes such as photosynthesis, respiration and biogeochemical cycling (Hunter, 2002). Through time, these ecological processes contribute to natural selection, which shapes each species' genetic diversity and drives evolution (Dobson, 1998).

Figure 2.1.3 presents a summary of biodiversity in terms of the variety of life, the levels in which it is organised, and the processes critical to its maintenance (Noss, 1990; Groves, 2003).

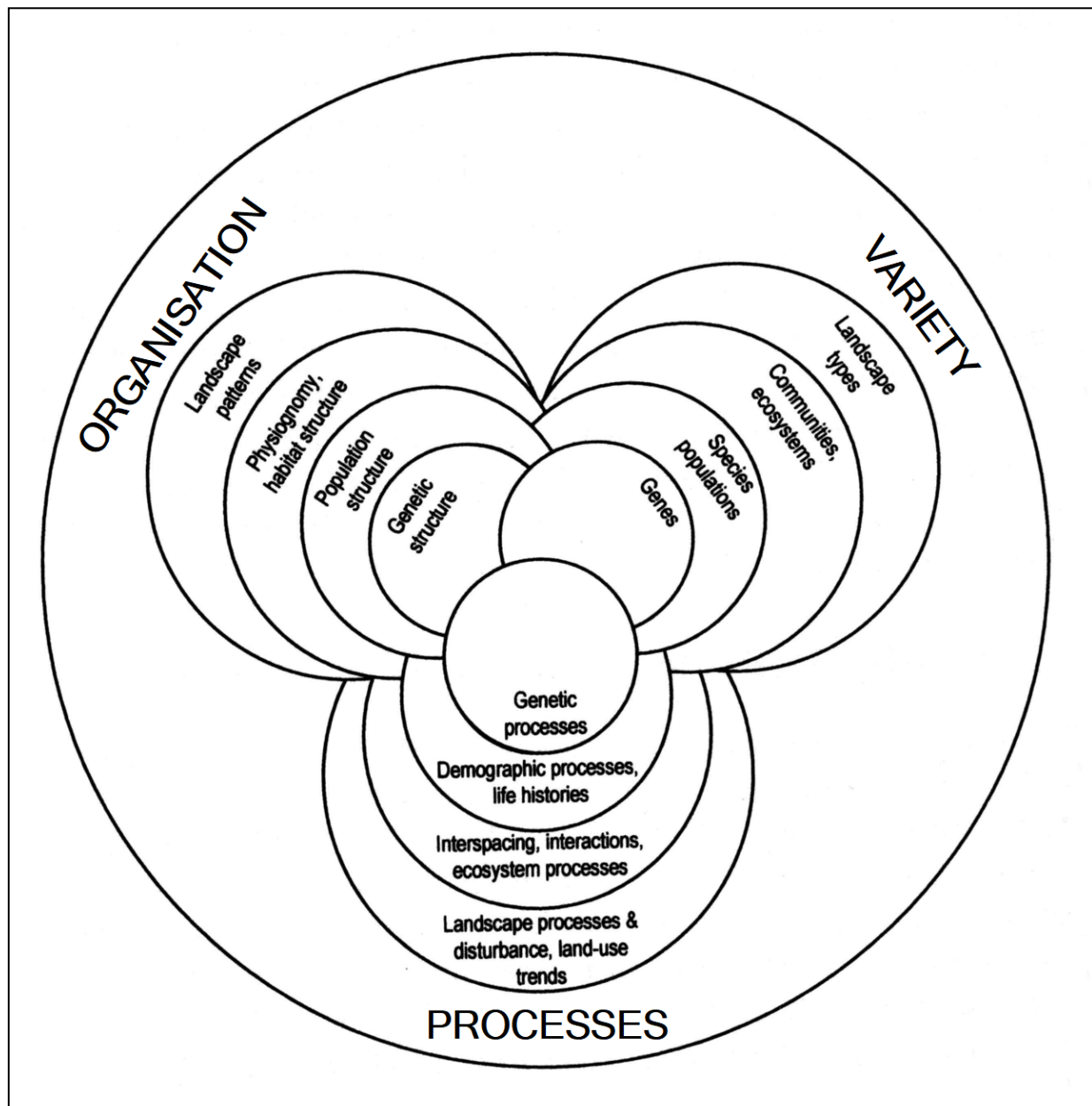


Figure 2.1.3: Biodiversity – Variety, Organisation and Processes

Biodiversity encompasses different forms of life, organised at different levels and maintained through ecological and evolutionary processes.

Modified from: Groves, C. (2003). Drafting a Conservation Blueprint, p.8.

2.2 The Nested Approach to Conservation Planning

As biodiversity encompasses a range of different levels, including genes, species, ecosystems and landscapes, conservation planning also needs to encompass these different levels. This often causes confusion, as the different levels of biodiversity are partially nested (refer to Figure 2.2.1).

Higher levels, such as landscapes and ecosystems, capture a greater range of biodiversity, including both known and unknown species and a myriad of associated processes. However, a focus on conserving a representative sample of landscapes and ecosystems will not encompass all species and processes. Those missed will require specific management.

This split has been explained through the metaphor of coarse and fine filters (Noss, 1987; Hunter, 2002). Conservation focussed on obtaining representative samples of landscapes and ecosystems is termed the ‘coarse filter’, as it acts as a surrogate for broader biodiversity, picking up a multitude of species, levels of organisation and processes. However, some species and processes are not picked up through such an approach and require individually focussed efforts; this is termed the ‘fine filter’. Reserve acquisition is typically based on ‘coarse-filter’ approaches, while threatened species recovery is more a ‘fine-filter’ approach (Groves, 2003).

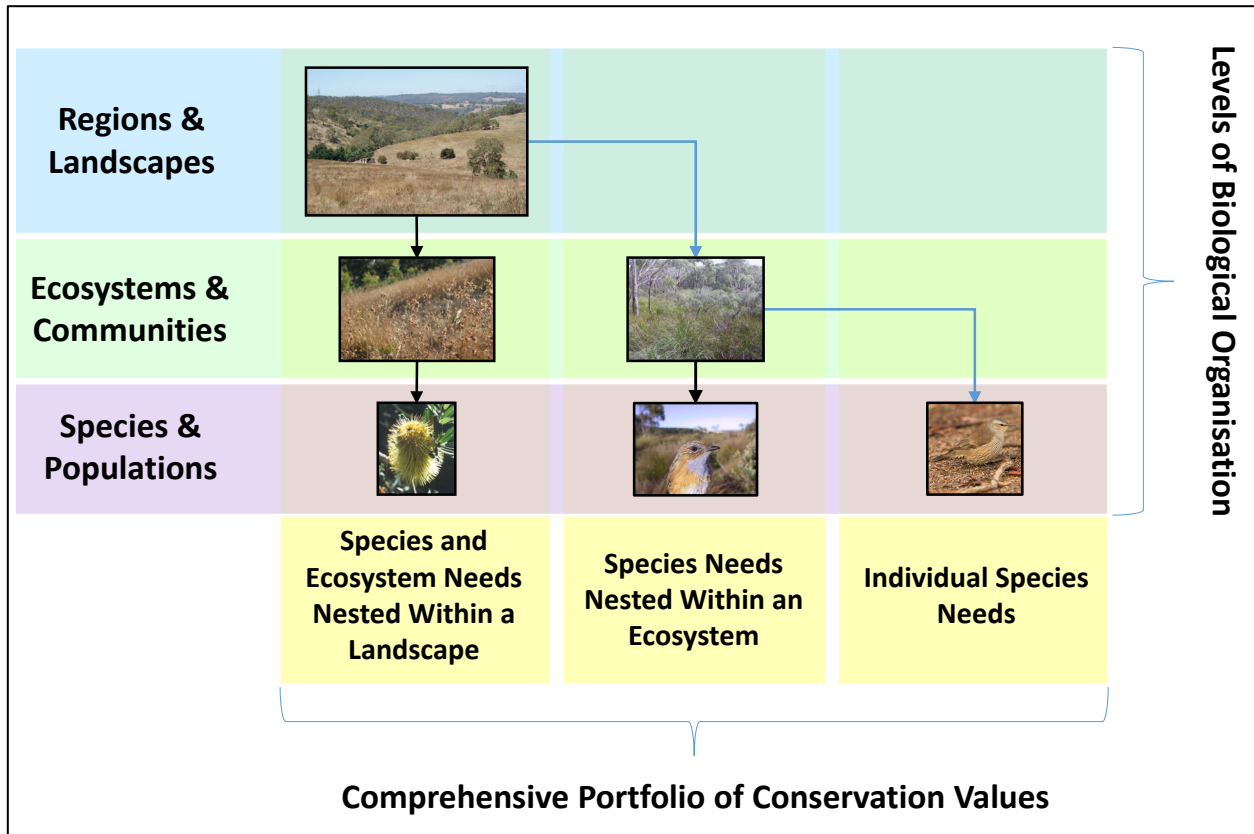


Figure 2.2.1: The Partially Nested Nature of Biodiversity and Conservation Planning Logic

Biodiversity is organised at a number of different levels. As a result, it is often possible to implement management actions required at the highest level (such as landscapes) and automatically address the needs of the subordinate ecosystems and species (if these needs are nested). However, there will always be some components of biodiversity that have idiosyncratic management needs that are not shared with the higher levels of organisation (these are not nested). A comprehensive but efficient portfolio of conservation values and management responses can be developed by ensuring coverage across the higher levels of the biological hierarchy, and extending to the lower levels just for those values and issues that are not nested.

2.3 Implications for Protected and Conserved Areas

These concepts have important implications for protected and conserved areas. For example, formal protected areas can focus on protecting remnant or restored habitats important for biodiversity values that range from landscapes (coarse-filter values) through to species (fine-filter values), both now and under future climate scenarios (Rosenblum, 2021). In addition, new approaches to conservation can also recognise and manage areas that may be critical to biodiversity but which are primarily managed for other purposes (so-called other effective area-based conservation measures, OECMS; Jonas et al., 2024).

3. Approaches to Protected Area Selection and Assessment

Over the last 30 years in Australia (and South Australia), the sufficiency of the protected area system and the identification of priorities for future acquisition has been guided by the use of the Interim Biogeographic Regionalisation of Australia (IBRA; Thackway and Cresswell, 1995) combined with the principles of a Comprehensive, Adequate, Representative Reserve System (CARRS; CoA, 1992).

The CARRS approach was originally introduced by the Commonwealth in 1992 as part of the 'National Forest Policy Statement' (CoA, 1992) and has subsequently been redefined multiple times (CoA, 1995; CoA, 1997; CoA, 2010).

IBRA classifies Australia's landscapes into 89 geographically distinct bioregions based on common climate, geology, landform, native vegetation and species information. Nested within these bioregions are 419 subregions which are smaller, more homogenous ecological units (DCCEEW, 2023).

3.1 Geographic Interpretation

The geographic interpretation of CARRS emphasizes the degree to which the protected area system samples environmental patterns, particularly the range of ecosystems within landscapes of increasing spatial extent, as well as arbitrary thresholds for the amount of each ecosystem included within the protected area network. The assumption from this approach is that higher levels of the biological hierarchy (coarse-filter units such as landscapes and ecosystems) are effective surrogates for lower levels of the hierarchy (like species and populations). However, this is rarely the case (Lindenmayer et al., 2015).

Below are the CARRS definitions from CoA (2010), which emphasizes the geographic interpretation:

- **Comprehensive:** Refers to the aim of including samples of the full range of regional ecosystems within and across each IBRA bioregion.
- **Adequate:** Refers to how much of each ecosystem should be sampled to provide ecological viability and integrity of populations, species and ecological communities at a bioregional scale.
- **Representative:** Refers to comprehensiveness considered at a finer scale (IBRA subregion), and recognises that the regional variability within ecosystems is sampled within the reserve system.

Across Australia and within South Australia, the CARRS framework has traditionally been assessed by determining the percentage of each IBRA bioregion and subregion captured within protected areas. A minimum threshold is then used to decide the adequacy of that protection. This threshold was originally set at 10% (DEWHA, 2009); under the International Kunming-Montreal Global Biodiversity Framework (CBD, 2022), a more ambitious target of 30% has been proposed.

3.1.1 Data and Methods

To calculate the geographic interpretation of CARRS, there is a need to bring together the latest information on protected areas across different tenures with the latest version of IBRA (which is version 7.1; DCCEEW, 2023).

Protected areas in South Australia were limited to those with a legal basis to protection. This included protected areas on both public and private land (refer to Table 3.1.1).

Table 3.1.1 Types of protected areas in South Australia

Land Tenure	Type of Protected Area	Legal Basis for Protection
Public Land	Conservation Parks (including co-managed parks)	<i>National Parks and Wildlife Act 1972</i>
	Game Reserves	
	National Parks (including co-managed parks)	
	Recreation Parks	
	Regional Reserves	
	Crown Land Reserve	<i>Crown Lands Management Act 2009</i>
	Native Forest Reserve	<i>Forestry Act 1950</i>
	Wilderness Protected Areas (and Zones including co-managed Areas)	<i>Wilderness Protection Act 1992</i>
Public or Private Land	Indigenous Protected Areas	Through agreement with the Australian Government
Private Land	Private conservation reserves	Through agreement with the Australian Government
	Arkaroola Protection Area	<i>Arkaroola Protection Act 2012</i>
	Heritage Agreements	<i>Native Vegetation Act 1991</i>

The percentage of land protected was calculated for both IBRA Regions and Subregions. As biogeographic units, the Regions and Subregions often extend across jurisdictional borders. In these instances, the entire extent of the unit was assessed, including the percentage of each unit protected across all relevant jurisdictions. The percent of each IBRA Region and Subregion within South Australia was calculated, to provide additional context for the assessment (refer to Table 3.1.2).

Priorities were then generated based on current of level of protection at the IBRA Region and Subregion levels:

- High Priority – where IBRA Region and Subregion levels of protection were both below 10%
- Mid Priority – where both IBRA Region and Subregion levels of protection were below 30% with one level being below 10% protection
- Low Priority – where both IBRA Region and Subregion levels of protection were above 30%.

3.1.2 Results

Figure 3.1.2 presents a summary of the current levels of protection across South Australia using the geographic approach. Table 3.1.2 presents a detailed breakdown of the resulting area and percentage statistics.

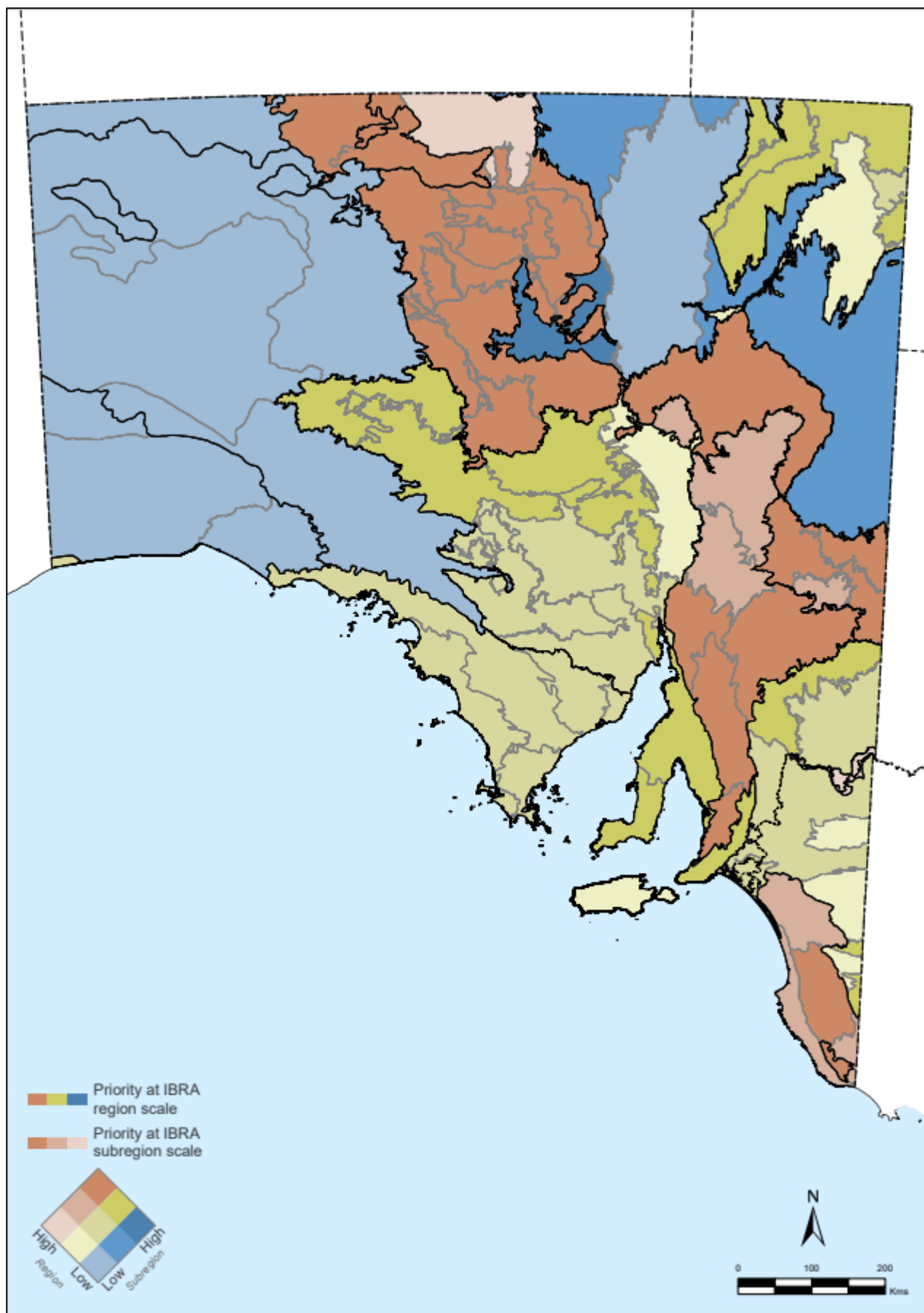


Figure 3.1.2: Geographic CARRS Assessment

Table 3.1.2: Geographic CARRS Assessment Summary Statistics

IBRA Region Name	IBRA Region (hectares)	Percent of IBRA Region in SA	IBRA Region Protected (Percent)	IBRA Subregion Name	IBRA Subregion (hectares)	Percent of IBRA Subregion in SA	IBRA Subregion Protected (Percent)	Geographic Assessment
Broken Hill Complex	5,608,889	33	4.691	Barrier Range	1,794,431	21	2.826	High Priority
				Mootwingee Downs	627,889	0	19.896	Low Priority
				Scopes Range	259,547	0	0	Low Priority
				Barrier Range Outwash	1,945,768	26	0.791	High Priority
				Bimbowrie	277,906	100	25.715	Mid Priority
				Curnamona	703,348	100	0.087	High Priority
Central Ranges	10,238,734	28	80.725	Mann-Musgrave Block	9,287,390	20	83.731	Low Priority
				Watarru	424,119	100	73.684	Low Priority
				Everard Block	527,225	100	33.431	Low Priority
Channel Country	30,640,356	17	10.957	Toko Plains	2,887,760	0	10.575	Low Priority
				Sturt Stony Desert	8,995,149	25	6.609	Mid Priority
				Goneaway Tablelands	5,254,506	0	16.566	Low Priority
				Diamantina-Eyre	1,472,691	17	0	Mid Priority
				Cooper-Diamantina Plains	4,164,149	17	5.33	Mid Priority
				Coongie	1,738,464	100	46.469	Low Priority
				Lake Pure	1,208,979	18	15.398	Low Priority
				Noccundra Slopes	1,800,979	0	0.774	Low Priority
				Core Ranges	138,766	0	7.051	Low Priority

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				Bulloo	1,075,480	0	31.119	Low Priority
				Bulloo Dunefields	1,324,825	0	0	Low Priority
				Central Depression	578,609	0	2.198	Low Priority
Eyre Yorke Block	6,095,895	100	15.449	Southern Yorke	437,410	100	8.462	Mid Priority
				St Vincent	1,089,793	100	1.287	Mid Priority
				Eyre Hills	1,168,057	100	13.438	Low Priority
				Talia	1,091,664	100	20.258	Low Priority
				Eyre Mallee	2,308,971	100	22.2	Low Priority
Finke	7,325,140	26	4.567	Henbury	2,282,361	0	11.042	Low Priority
				Finke River	1,615,292	0	4.505	Low Priority
				Tieyon	2,521,195	40	0.387	High Priority
				Pedirka	906,293	100	0	High Priority
Flinders Lofty Block	6,587,005	100	9.159	Mount Lofty Ranges	299,880	100	5.846	High Priority
				Broughton	1,028,758	100	0.519	High Priority
				Olary Spur	1,737,276	100	0.993	High Priority
				Southern Flinders	724,854	100	4.698	High Priority
				Northern Flinders	1,839,170	100	22.604	Mid Priority
				Central Flinders	957,067	100	11.85	Mid Priority
Gawler	11,950,781	100	15.04	Myall Plains	1,083,683	100	10.485	Low Priority
				Gawler Volcanics	1,548,719	100	12.262	Low Priority
				Gawler Lakes	2,039,398	100	27.859	Low Priority
				Arcoona Plateau	1,084,865	100	0.096	Mid Priority

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				Kingoonya	1,914,419	100	6.919	Mid Priority
				Torrens	1,432,927	100	54.2	Low Priority
				Roxby	1,403,535	100	0.237	Mid Priority
				Commonwealth Hill	1,443,235	100	0.85	Mid Priority
Great Victoria Desert	42,227,370	48	42.981	Shield	4,733,200	0	9.659	Low Priority
				Central	12,601,255	0	30.106	Low Priority
				Maralinga	11,451,925	66	56.42	Low Priority
				Kintore	4,973,987	88	63.488	Low Priority
				Tallaringa	3,659,405	100	44.492	Low Priority
				Yellabinna	4,807,598	100	55.152	Low Priority
Hampton	1,082,940	4	14.712	Hampton	1,082,940	4	14.712	Low Priority
Kamantoo	811,553	100	20.574	Kangaroo Island	441,502	100	34.483	Low Priority
				Fleurieu	370,051	100	3.979	Mid Priority
Murray Darling Depression	19,905,388	28	19.374	South Olary Plain	5,417,183	22	18.927	Low Priority
				Murray Mallee	5,027,247	42	14.14	Low Priority
				Murray Lakes and Coorong	248,947	100	17.243	Low Priority
				Lowan Mallee	2,389,796	41	72.714	Low Priority
				Wimmera	2,148,579	6	2.341	Mid Priority
				Darling Depression	3,645,340	0	7.844	Low Priority
				Braemer	1,028,295	94	0.339	Mid Priority
Naracoorte Coastal Plain	2,464,767	83	9.803	Bridgewater	465,483	96	11.338	Mid Priority
				Glenelg Plain	557,651	28	12.689	Mid Priority

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				Lucindale	733,612	100	4.2	High Priority
				Tintinara	708,021	100	12.328	Mid Priority
Nullarbor	19,641,393	30	55.16	Carlisle	5,769,866	12	84.318	Low Priority
				Nullarbor Plain	12,727,984	32	39.867	Low Priority
				Yalata	1,143,542	100	78.268	Low Priority
Riverina	9,686,022	2	5.855	Lachlan	2,368,160	0	3.356	Low Priority
				Murrumbidgee	2,939,519	0	4.075	Low Priority
				Murray Fans	1,950,623	0	6.07	Low Priority
				Victorian Riverina	1,892,218	0	3.301	Low Priority
				Robinvale Plains	161,536	0	33.842	Low Priority
				Murray Scroll Belt	373,967	44	35.367	Low Priority
Simpson Strzelecki Dunefields	28,131,437	49	30.717	Andado	1,372,663	0	0	Low Priority
				Simpson Desert	13,102,606	14	22.998	Low Priority
				Dieri	5,159,928	94	81.79	Low Priority
				Warriner	1,030,410	100	0.416	Low Priority
				Strzelecki Desert	7,465,831	80	18.794	Low Priority
Stony Plains	13,160,312	98	6.807	Breakaways	2,443,528	99	5.46	High Priority
				Oodnadatta	2,592,776	100	2.827	High Priority
				Murnpeowie	2,901,403	100	2.201	High Priority
				Peake-Dennison Inlier	158,452	100	0	High Priority
				Macumba	694,825	100	3.331	High Priority
				Witjira	1,685,030	89	33.039	Low Priority

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				Baltana	2,684,298	100	1.693	High Priority
Southern Volcanic Plain	2,454,220	3	2.196	Victorian Volcanic Plain	2,369,575	0	2.167	Low Priority
				Mount Gambier	84,645	100	2.996	High Priority

3.1.3 Strengths and Limitations

Strengths

The strengths of the geographic interpretation of CARRS is that it is simple to apply (and to track changes through time), as it requires only very coarse spatial pattern-based information (such as vegetation or land unit mapping) to evaluate or implement. It also enables comparison with previous assessments (that relied upon the geographic approach) to assess change. Also, by protecting broad ecological units, the approach may encapsulate unknown biodiversity values (Hunter, 2002).

Limitations

The main drawback is that geographic patterns are a poor surrogate for biodiversity values and may be unrelated to achieving outcomes for biodiversity. This lack of alignment is likely to worsen under future change scenarios (Lindenmayer et al., 2015; Groves and Game, 2016; Wiens, 2016). In addition, without the specific identification of conservation values, there is no basis for evaluating performance or identifying management needs. As such, there is a need for a more specific values and outcome-based interpretation.

3.2 Outcome Interpretation

To address some of the known limitations of the geographic approach, an alternative ‘values and outcomes’ approach has also been applied within South Australia. Rather than using the percentage of coarse ecological units as a surrogate for biodiversity, this approach instead considers how irreplaceable each patch of habitat is, based on how reliant species are upon each patch (Kirkpatrick, 1983; Margules and Pressey, 2000). All areas critical to the long-term conservation of one or more species of conservation concern are then highlighted as a priority for protection.

Under an outcome-based interpretation of CARRS, the following interpretation was applied (Lindenmayer and Burgman, 2005):

- Comprehensive: coverage across the full range of biodiversity values, including species (not just coarse-filter considerations, such as ecosystems and landscapes).
- Adequate: ensuring protection of all areas important to the viability of biodiversity values.
- Representative: Under this interpretation, the emphasis would be on sampling conservation values across their geographic ranges, to maintain adaptive capacity and also to ensure there are sufficient examples to mitigate risks (such as the loss from catastrophic events; this has been framed as a ‘replication’ principle by Lindenmayer and Franklin, 2002).

The ‘values and outcomes’ approach has only been applied to the South Australian agricultural zone, as data paucity issues currently preclude its application to the arid zone. Work has commenced that will enable the Statewide application of this approach, which will be captured in future updates of the Protected and Conserved Area Strategy.

In the meantime, both the geographic and outcome approach have been applied to ensure coverage across the State.

3.2.1 Data and Methods

The outcome interpretation of CARRs emphasizes the degree to which the design of the protected area system is necessary to ensure conservation outcomes for specific biodiversity values.

The first step in the process was to define habitat patches. These were derived from a combination of three spatial products:

- The Ecosystems of SA dataset (Willoughby et al., 2021), which classifies plot-based vegetation data into vegetation types, and then spatially predicts these across the State using environmental datasets and remote sensing at a resolution of 30 x 30 metre cells.
- The Landuse 2020 dataset (Hobbs, 2022), which uses field-based landuse records and remote sensing data to spatially predict landuse types across the State at a resolution of 10 x 10 metre cells.
- SA Vegetation mapping (DEW, 2023b), which is a composite dataset of vegetation mapping derived from manual aerial photography interpretation (undertaken over a 30 year period).

Vascular plant and vertebrate species records were then taxonomically aligned and collated from the Biological Databases of South Australia, the SA Supertable, and Atlas of Living Australia. Those records with sufficient spatial reliability were then attributed to the habitat patch within which they were found.

A weighted approach to irreplaceability calculation was then applied to determine the importance of each habitat patch in terms of its contribution to species conservation. Due to the very large number of habitat patches to be assessed (several million), the approach used to calculate irreplaceability followed that of Kirkpatrick et al. (2017) rather than using optimisation tools such as MARXAN and ZONATION. This is because the computation of optimisation can become intractable with such large datasets (Serra-Sogas et al., 2020).

The approach applied to irreplaceability calculation also applied weights to the species based on their level of extinction risk, following the Red List standards (IUCN, 2012). Highest weight was given to those species assessed as being at high risk of extinction in the wild, with moderate weight given to species that are near threatened, and no weight applied those of least concern.

A threshold was then applied to the resulting weighted irreplaceability metric. This threshold was chosen to separate habitat patches that no longer contained species that were at high risk or extinction or near threatened. Those patches with irreplaceability values above the threshold were then considered 'irreplaceable' from a protection perspective.

The proportion of unprotected irreplaceable habitat in each IBRA Subregion was then determined. This was achieved by dividing the area of unprotected irreplaceable habitat by the total area of irreplaceable habitat within each Subregion and was used to generate priorities for protection:

- High Priority – where more than 30% of irreplaceable habitat in an IBRA Subregion is unprotected.
- Mid Priority – where more than 10% of irreplaceable habitat in an IBRA Subregion is unprotected.
- Low Priority – where less than 10% of irreplaceable habitat in an IBRA Subregion is unprotected.

3.2.2 Results

Figure 3.2.2 presents a summary of the current levels of protection across South Australia based on the values and outcomes approach to CARRS. Table 3.2.2 presents a detailed breakdown of the resulting area and percentage statistics.

The results of the values and outcomes approach can differ significantly to those generated through the geographic approach because:

- irreplaceable areas may occur in bioregions that already have many protected areas;
- bioregions with very few protected areas will not automatically be identified as a priority, if there is little left to conserve.

3.2.3 Strengths and Limitations

Strengths

The strength of the outcome-based approach to CARRS is that it is directly linked to the intended biodiversity outcomes that the reserve system is intended to support. It also provides a clear connection between the outcomes being sought, management needs and performance measures, as specific conservation values are identified.

Limitations

The drawback of the outcome-based approach is that it requires significantly more data, analysis and effort to apply and track changes (as specific values need to be identified). In addition, there will always be data gaps associated with different aspects of biodiversity (any outcome-based approach will be incomplete in terms of its coverage across all aspects of biodiversity). As such, surrogates for data gaps are likely to be required.

The data paucity issues across the South Australian arid zone have currently precluded application in this part of the State (refer to Figure 3.2.3). Additional analytical work has commenced that will enable the Statewide application of the outcome approach, which will be captured in future updates of the Protected and Conserved Area Strategy.

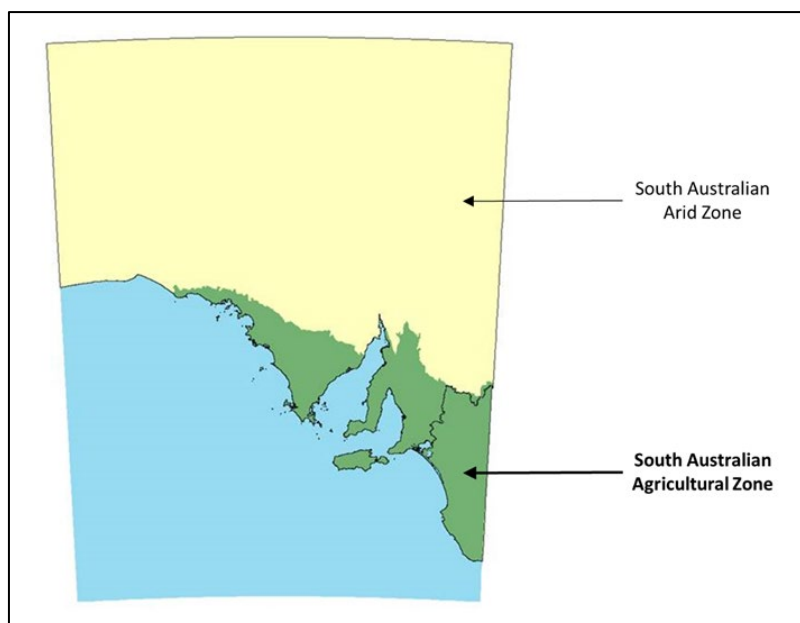


Figure 3.2.3: Extent of the South Australian Agricultural Zone

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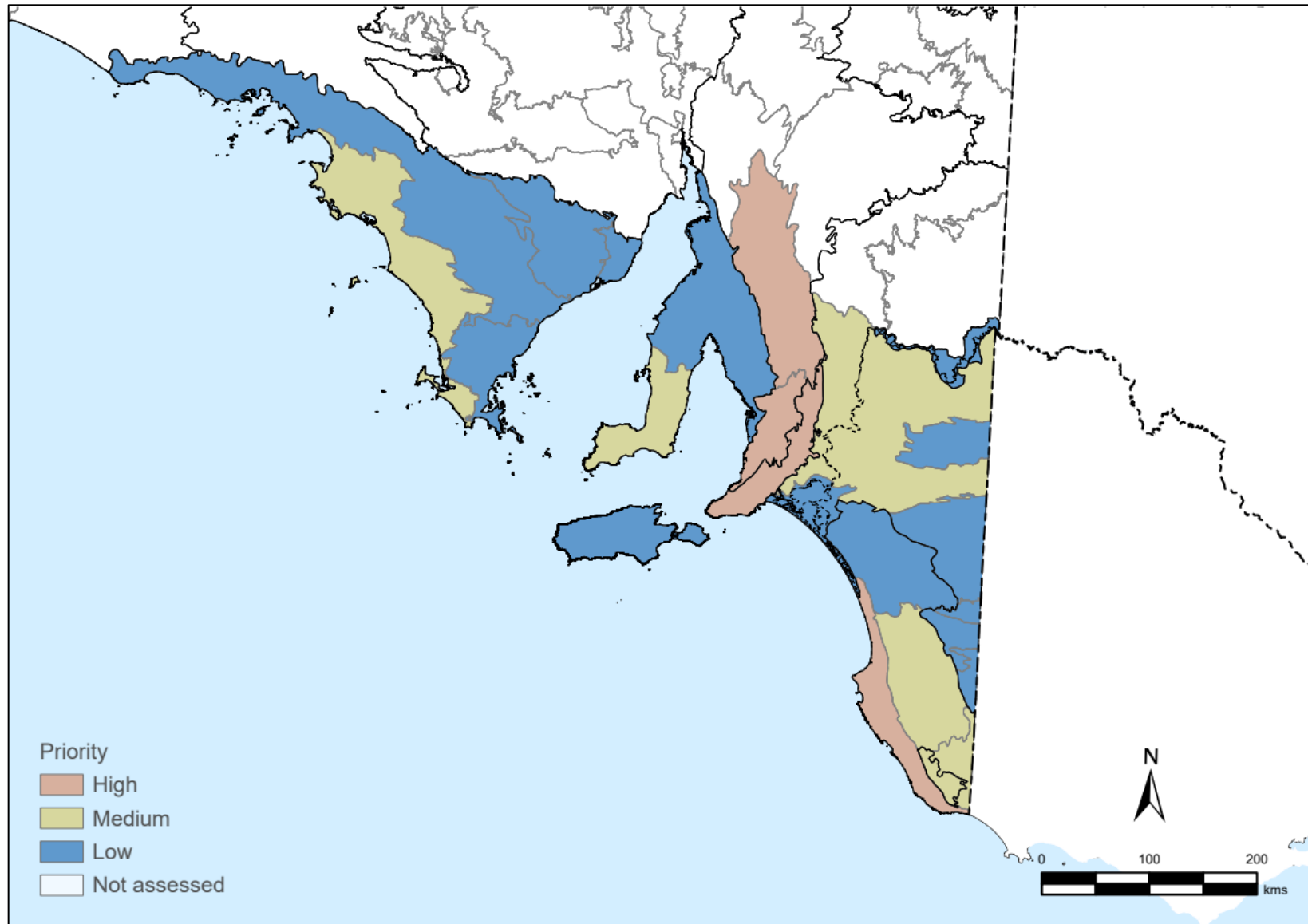


Figure 3.2.2: Values and Outcomes Based CARRS Assessment for the South Australian Agricultural Zone

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Table 3.2.2: Values and Outcomes CARRS Assessment Summary Statistics

IBRA Region Name	IBRA Region (hectares)	Percent of IBRA Region in SA	IBRA Region Protected (Percent)	IBRA Subregion Name	IBRA Subregion (hectares)	Percent of IBRA Subregion in SA	IBRA Subregion Protected (Percent)	Outcome Assessment
Eyre Yorke Block	6,095,895	100	15.449	Southern Yorke	437,410	100	8.462	Mid Priority
				St Vincent	1,089,793	100	1.287	Low Priority
				Eyre Hills	1,168,057	100	13.438	Low Priority
				Talia	1,091,664	100	20.258	Mid Priority
				Eyre Mallee	2,308,971	100	22.2	Low Priority
Flinders Lofty Block	6,587,005	100	9.159	Mount Lofty Ranges	299,880	100	5.846	High Priority
				Broughton	1,028,758	100	0.519	High Priority
Kanmantoo	811,553	100	20.574	Kangaroo Island	441,502	100	34.483	Low Priority
				Fleurieu	370,051	100	3.979	High Priority
Murray Darling Depression	19,905,388	28	19.374	Murray Mallee	5,027,247	42	14.14	Mid Priority
				Murray Lakes and Coorong	248,947	100	17.243	Low Priority
				Lowan Mallee	2,389,796	41	72.714	Low Priority
				Wimmera	2,148,579	6	2.341	Low Priority
Naracoorte Coastal Plain	2,464,767	83	9.803	Bridgewater	465,483	96	11.338	High Priority
				Glenelg Plain	557,651	28	12.689	Mid Priority
				Lucindale	733,612	100	4.2	Mid Priority
				Tintinara	708,021	100	12.328	Low Priority
Riverina	9,686,022	2	5.855	Murray Scroll Belt	373,967	44	35.367	Low Priority

Southern Volcanic Plain	2,454,220	3	2.196	Mount Gambier	84,645	100	2.996	Mid Priority
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4. Climate Change Sensitivity and Opportunities to Increase Resilience

Climate change poses a significant threat to biodiversity and protected area planning can play a useful role in supporting adaptation (SCDB, 2020; Rosenblum, 2021). In a review of opportunities to protect biodiversity given the challenges of climate change, Heller and Zavaleta (2009) identified over 100 distinct actions. These can be summarised under a few broad strategies (refer to Figure 4).

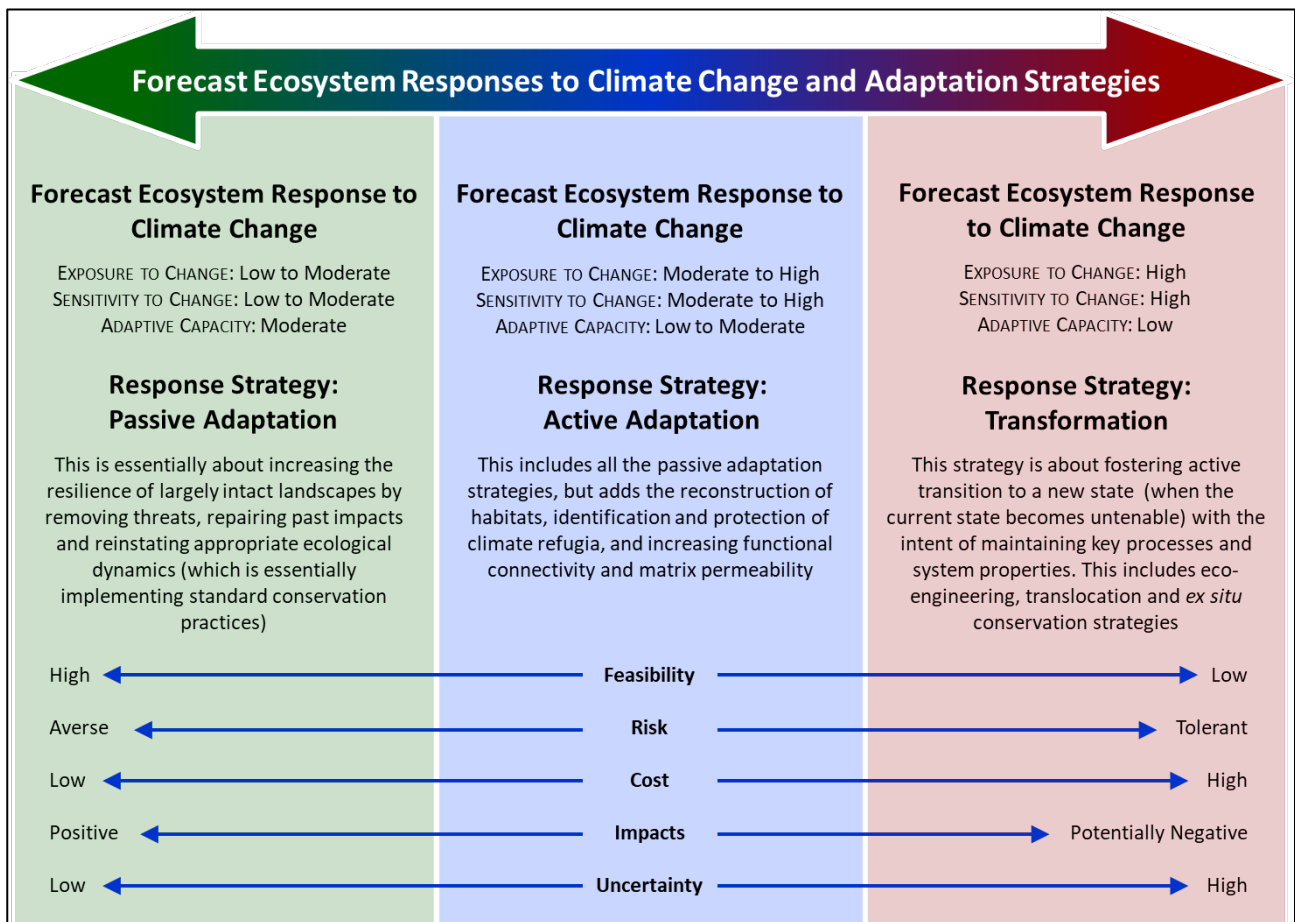


Figure 4: Broad Biodiversity Response Strategies in Response to Climate Change (modified from Heller and Zavaleta, 2009).

However, just ensuring that protection and conservation addresses the identified CARRS priorities (part of the ‘passive adaptation’ response strategy in Figure 4) will not be sufficient (Groves and Game, 2016). In addition to ‘passive adaptation’, there will also be a need for more ‘active adaptation’ to build the ecological resilience through the reconstruction of habitat, increasing population viability, and protecting areas with the potential to form climate refugia (Heller and Zavaleta, 2009; Rosenblum, 2021).

As part of the development of the Protected and Conserved Area Strategy, the department has used analyses from the values and outcomes work to identify where additional restoration and protection will be most important to support the resilience of biodiversity to climate change.

4.1 Climate Sensitivity

To understand climate sensitivity, the department has sought to identify IBRA Subregions with a high proportion of species sensitive to climate change. This highlights areas where increasing ecological resilience is likely to be a critical component of successful long-term conservation.

4.1.1 Data and Methods

The vascular plant and vertebrate species records that were brought together for the values and outcomes assessment (Section 3.2) were again used as inputs to evaluate climate sensitivity, as were the defined habitat patches (based on the Ecosystems of SA, Landuse 2020 dataset, and SA Vegetation Mapping; Willoughby et al., 2021; Hobbs, 2022; DEW, 2023b).

In addition, historic annual gridded climatic data was collated from the Bureau of Meteorology (BOM), along with NARcliM 1.5 future climate projection data from (DPIE, 2020).

The relationship between effort-adjusted species reporting trends through time (using a variation of list-length analysis; Szabo et al., 2010; DEW, 2023a) and the BOM climatic variables was modelled using an individually tuned multilayer perceptron approach (Rumelhart et al., 1986; West, 2016). Each climate-species model was then applied under a future climate scenario (using NARcliM 1.5 at 2050 based on the worst case scenario of SSP5-8.5; IPCC, 2023) to determine the predicted trend for each species. The resulting future scenario for each species was then categorised by those showing a clear negative trend response, a clear positive trend response, or no clear change.

The climate sensitivity of each habitat type was then calculated from the predicted climate trends of the species found within them. Those habitat types dominated by species with negative trends under the future climate scenario were identified as having very high sensitivity to future change, while those habitat types dominated by species with positive trends or no clear change under future climate scenarios were identified as having as being insensitive to future change.

4.1.2 Results

Figure 4.1.2 presents a summary of the climate sensitivity of habitat types across the South Australian agricultural zone, based upon the response of their component species.

4.1.3 Strengths and Limitations

Strengths

The main strength of this approach is its ability bring together individual species trend implications under future climate scenarios and combining these through their habitat affinities in a manner that provides spatially-explicit insights. This is an improvement on more common approaches that tend to focus on generic climate response strategies (Lawler and Michalak, 2018).

Limitations

There are also several limitations associated with the current approach. Firstly, only one future climate scenario was examined. To fully explore future climate implications, it's necessary to look across the full range of future scenarios (IPCC, 2023). Secondly, it would be more informative to understand the specific mechanisms of change associated with each species, how these influence their sensitivity, and what adaptation opportunities exist (such as ability to move, adjust or adapt; Rosenblum, 2021).

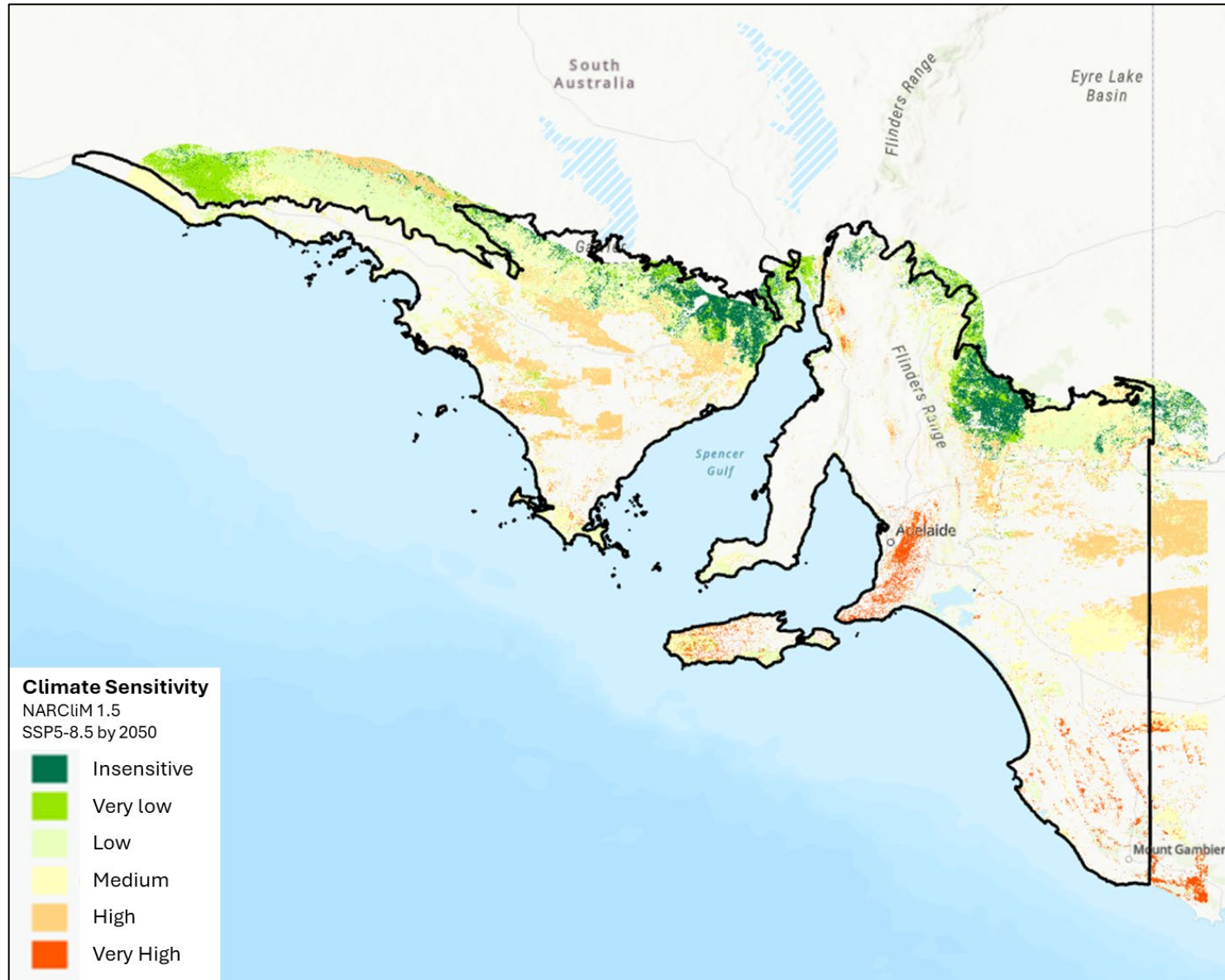


Figure 4.1.2: Habitats with a High Proportion of Climate Sensitive Species

Finally, it is also important to be able undertake biodiversity and climate change assessments across the biological hierarchy (refer to Section 2.2), as this provides a more comprehensive framework for understanding potential change (Prober et al., 2012). For example, while many of the species associated with coastal samphire communities are not directly sensitive to changes in climatic variables, the ecosystems in which they occur may still collapse through climate-mediated sea level rise and impediments to coastal migration (DSEWPC, 2013; Enwright et al., 2016).

4.2 Restoration Priorities

Similar to the approach used for patches of remnant habitat (outlined in Section 3.2), restoration opportunities can also be assessed in terms their potential to provide irreplaceable habitat for species of conservation concern.

4.2.1 Data and Methods

The vascular plant and vertebrate species records that were brought together for the values and outcomes assessment (Section 3.2) were again used as part of evaluating restoration priorities. However, in this case, rather than remnant habitat patches, opportunities for potential restoration were identified from landcover layers; these were essentially areas without infrastructure that would preclude habitat restoration (such as build areas or infrastructure, or areas with extensive modification).

Each potential restoration patch was then attributed with existing vascular plant and vertebrate species records from within the patch and from remnant habitat directly adjacent to the patch. This enabled the same weighted approach to irreplaceability calculation used for remnant habitat (outlined in Section 3.2) to be applied to potential restoration opportunities (following Kirkpatrick et al., 2017). Again, weights were applied based on the level of species extinction risk, following the Red List standards (IUCN, 2012). Highest weight was given to those species assessed as being at high risk of extinction in the wild, with some weight given to species that are near threatened, and no weight applied those of least concern.

A threshold was then applied to the resulting weighted irreplaceability metric. This threshold was based on when potential restoration patches were no longer likely to support species that were at high risk of extinction or near threatened. Those patches with irreplaceability values above the threshold were then considered important for restoration.

The percent contribution of restored irreplaceable habitat in each IBRA Subregion was then determined. This was achieved by dividing the area of irreplaceable restoration opportunities by the total area of irreplaceable habitat (restored and remnant) within each Subregion. This was then used to generate priorities for restoration:

- High Priority – where more than 30% of irreplaceable habitat in an IBRA Subregion would be provided through restoration
- Mid Priority – where more than 10% of irreplaceable habitat in an IBRA Subregion would be provided through restoration
- Low Priority – where less than 10% of irreplaceable habitat in an IBRA Subregion would be provided through restoration

4.2.2 Results

Figure 4.2.2 presents a summary of the priority habitat restoration opportunities across the South Australian agricultural zone, based upon the collated requirements of individual species.

4.2.3 Strengths and Limitations

Strengths

The strength of this approach to restoration prioritisation is that it is directly linked to the intended biodiversity outcomes. It also provides a clear connection between individual species and the potential restoration opportunities, enabling performance evaluation.

Limitations

The drawback of this approach is that it requires significantly more data, analysis and effort to apply and track changes (as specific values need to be identified). In addition, there will always be data gaps associated with different aspects of biodiversity (any outcome-based approach will be incomplete in terms of its coverage across all aspects of biodiversity). As such, surrogates for data gaps are likely to be required.

The data paucity issues across the South Australian arid zone have currently precluded application in this part of the State (refer to Figure 3.2.3). Additional analytical work has commenced that will enable the Statewide application of this approach, which will be captured in future updates of the Protected and Conserved Area Strategy.

4.3 Combining Climate Sensitivity and Restoration Priorities

In order to determine those landscapes where habitat restoration is likely to be a significant requirement to address climate change, the outputs from Sections 4.1 and 4.2 were combined.

4.3.1 Data and Methods

The results from the climate sensitivity analysis (Section 4.1) identified those habitat patches across the South Australian agricultural zone with species sensitive to climate change. This patch-level climate sensitivity assessment was then summarised at the IBRA Subregion level by calculating the percent of climate sensitive habitat within each Subregion against the total area of habitat:

- High Climate Sensitivity – IBRA subregions where climate sensitive habitats comprise more than 30% of the total habitat
- Moderate Climate Sensitivity – IBRA subregions where climate sensitive habitats comprise more than 10% of the total habitat
- Low Climate Sensitivity – IBRA subregions where climate sensitive habitats comprise less than 10% of the total habitat

This assessment was then combined with the restoration priorities (Section 4.2) to determine those IBRA Subregions that were both climate sensitive and a priority for habitat restoration.

4.3.2 Results

Figure 4.3.2 presents a summary of IBRA Subregions characterised by climate sensitivity and priority restoration opportunities. Table 4.3.2 presents a detailed breakdown of the results and percentage statistics.

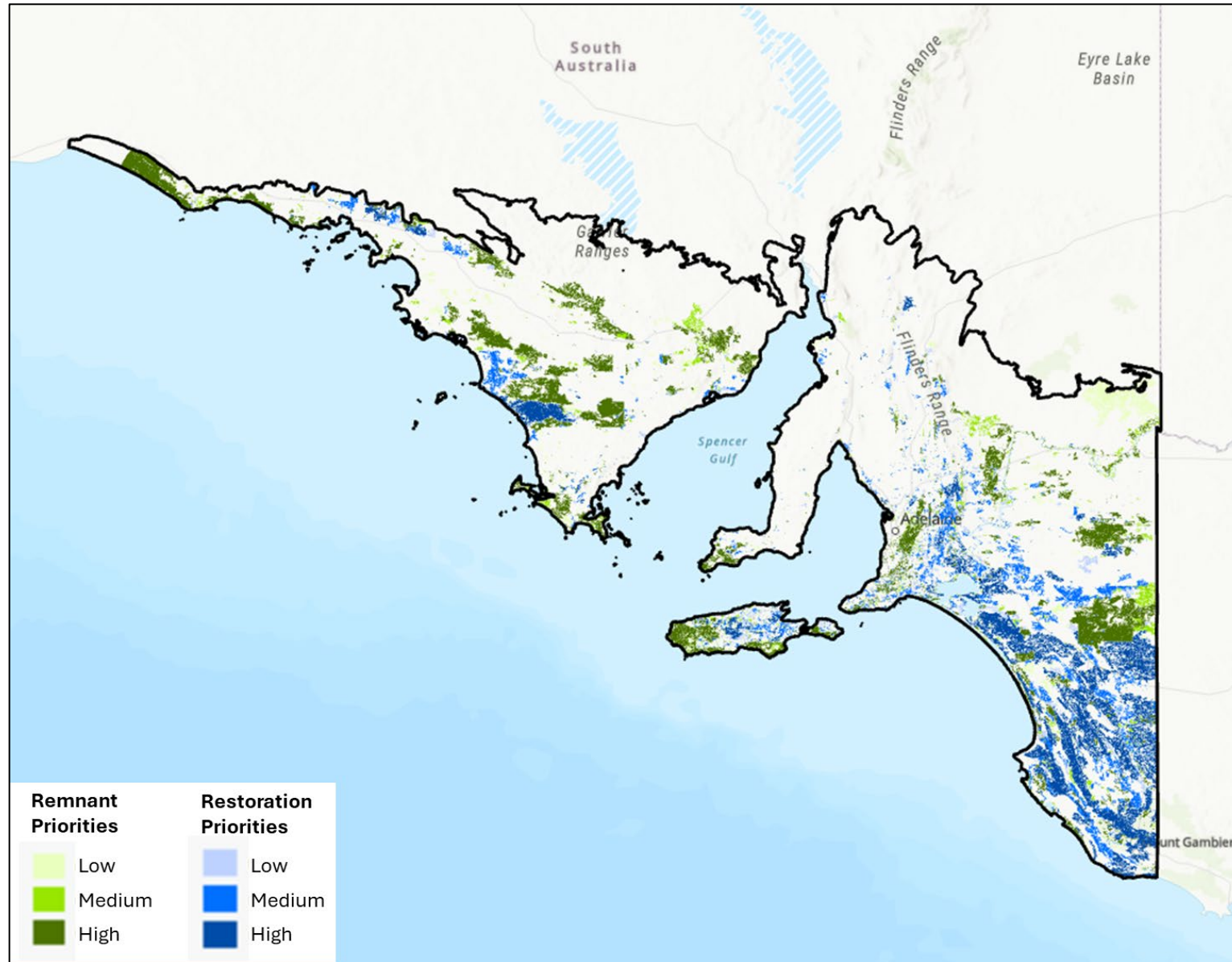


Figure 4.2.2: Restoration and Remnant Priorities based on Weighted Irreplaceability for Native Species for the South Australian Agricultural Zone

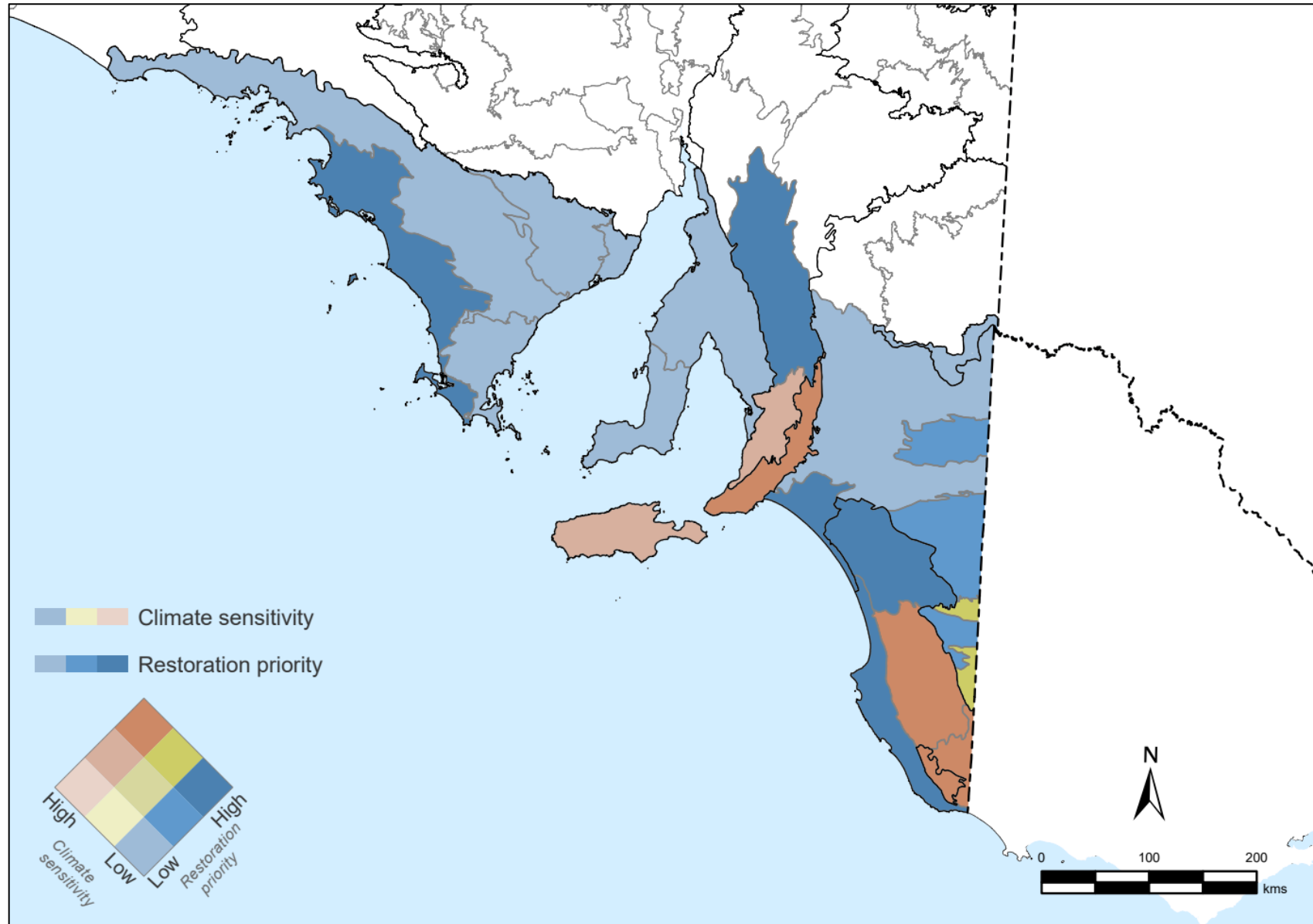


Figure 4.3.2: Combined Climate Sensitivity and Restoration Priorities for the South Australian Agricultural Zone

Table 4.3.2: Climate Sensitivity and Restoration Priority Summary Statistics

IBRA Region Name	IBRA Region (hectares)	Percent of IBRA Region in SA	IBRA Region Protected (Percent)	IBRA Subregion Name	IBRA Subregion (hectares)	Percent of IBRA Subregion in SA	IBRA Subregion Protected (Percent)	Priority Restoration Opportunities (Percent)	Priority Restoration Class	Climate Sensitivity (Percent)	Climate Sensitivity Class
Eyre Yorke Block	6,095,895	100	15.449	Southern Yorke	437,410	100	8.462	4.861	Low Priority Restoration	0.102	Low Climate Sensitivity
				St Vincent	1,089,793	100	1.287	9.413	Low Priority Restoration	0.063	Low Climate Sensitivity
				Eyre Hills	1,168,057	100	13.438	5.103	Low Priority Restoration	0.877	Low Climate Sensitivity
				Talia	1,091,664	100	20.258	32.691	High Priority Restoration	0.153	Low Climate Sensitivity
				Eyre Mallee	2,308,971	100	22.200	2.876	Low Priority Restoration	0.009	Low Climate Sensitivity
Flinders Lofty Block	6,587,005	100	9.159	Mount Lofty Ranges	299,880	100	5.846	19.604	Priority Restoration	61.076	High Climate Sensitivity
				Broughton	1,028,758	100	0.519	54.363	High Priority Restoration	0.676	Low Climate Sensitivity
Kanmantoo	811,553	100	20.574	Kangaroo Island	441,502	100	34.483	19.275	Priority Restoration	57.488	High Climate Sensitivity

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				Fleurieu	370,051	100	3.979	55.848	High Priority Restoration	50.228	High Climate Sensitivity
Murray Darling Depression	19,905,388	28	19.374	Murray Mallee	5,027,247	42	14.140	8.456	Low Priority Restoration	1.535	Low Climate Sensitivity
				Murray Lakes and Coorong	248,947	100	17.243	43.448	High Priority Restoration	5.167	Low Climate Sensitivity
				Lowan Mallee	2,389,796	41	72.714	10.101	Priority Restoration	2.564	Low Climate Sensitivity
				Wimmera	2,148,579	6	2.341	46.373	High Priority Restoration	21.401	Climate Sensitivity
Naracoorte Coastal Plain	2,464,767	83	9.803	Bridgewater	465,483	96	11.338	70.756	High Priority Restoration	8.647	Low Climate Sensitivity
				Glenelg Plain	557,651	28	12.689	44.792	High Priority Restoration	73.627	High Climate Sensitivity
				Lucindale	733,612	100	4.200	89.491	High Priority Restoration	31.398	High Climate Sensitivity
				Tintinara	708,021	100	12.328	70.808	High Priority Restoration	1.440	Low Climate Sensitivity
Riverina	9,686,022	2	5.855	Murray Scroll Belt	373,967	44	35.367	0.157	Low Priority Restoration	0.666	Low Climate Sensitivity
Southern Volcanic Plain	2,454,220	3	2.196	Mount Gambier	84,645	100	2.996	83.255	High Priority Restoration	69.922	High Climate Sensitivity

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4.3.3 Strengths and Limitations

The strengths and limitations of this approach have already been outlined in Sections 4.1.3 and 4.2.3.

5. Modified Landscapes and Natural Habitat Character

In addition to areas of remnant natural habitat and restoration opportunities, there are also modified landscapes, primarily used for other purposes, that retain habitat features critical to biodiversity conservation. These have been termed ‘modified landscapes with natural habitat character’.

5.1 Ecological Contrast and Natural Habitat Character

Ecological research over the past decade has highlighted the importance of specific modified landscapes in providing habitat requirements for species of conservation concern (Lindenmayer et al., 2023). The reason that some modified landscapes provide these requirements is because there is low ecological ‘contrast’ between the habitat required by species of conservation concern and the structure, function and dynamics of the modified landscape (Cunningham et al., 2013; refer to Figure 5.1).

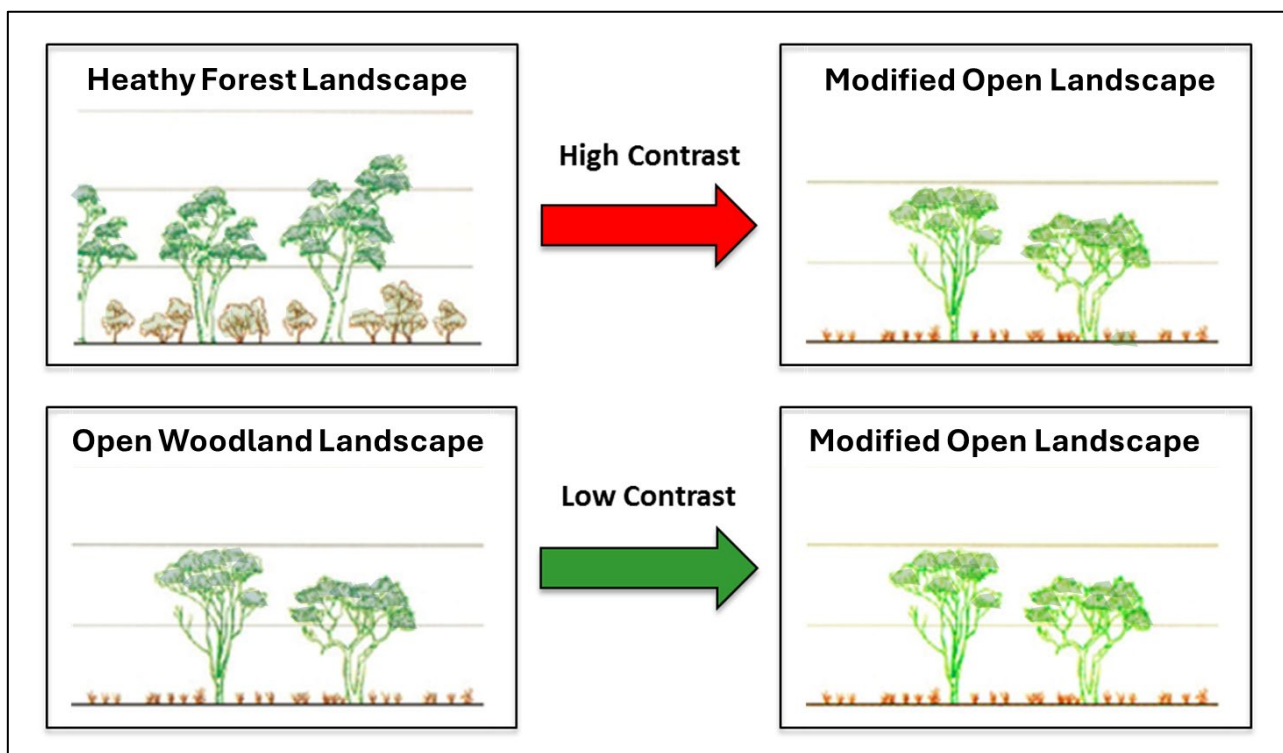


Figure 5.1: Ecological Contrast

This refers to the difference between the ecological structure, function and dynamics of an area before and after development. For example, there is high ecological contrast when moving from a dense heathy forest landscape to an open pasture-based production landscape, whereas there is much lower ecological contrast when moving from an open grassy woodland landscape to a low-input, pasture-based production landscape.

For example, survey work across the Mount Lofty Ranges revealed that some modified landscapes along the eastern side of the Ranges are a stronghold for species of conservation concern (particularly the nationally declining assemblage of ground-foraging woodland birds) that are not well conserved elsewhere in the region (Allen et al., 2018). This is because there is low ecological contrast between the habitat requirements of these species and the nature of developed land in these areas. Current land-use practices are dominated by low-input, extensive livestock production, which have retained critical habitat features (such as paddock trees and fallen timber), with introduced processes (such as grazing) maintaining open habitat at ground level, which is critical to ground-foraging wildlife.

5.2 Delineating Areas of Low Ecological Contrast

Providing a spatially explicit depiction of modified landscapes likely to provide habitat for species of conservation concern would ideally be derived from the occurrence of the species themselves. However, such modified landscapes are usually data deficient, as surveys tend to focus on remnant areas. Only the eastern Mount Lofty Ranges dataset deliberately surveyed modified landscapes (Allen et al., 2018), making this dataset useful for validation, but not able to be used as the primary input dataset across the entire agricultural zone. Instead, modified landscapes with natural habitat character can only be identified by evaluating:

- The prevalence of those habitat types with features that could persist in modified areas;
- Those types of land-uses that are likely to maintain low contrast habitat features (particularly broadacre land-uses, like low-input agricultural production systems).

The persistence of the key habitat features in modified areas is also usually reliant upon existing management regimes (such as low-input grazing systems). Formal protection would be undesirable in these circumstances, where existing management regimes may need to be maintained. Instead, such areas would be a useful focus for Other Effective Area-based Conservation Measures (OECMs; Jonas et al., 2024).

5.2.1 Data and Methods

The purpose of this analyses was to identify ‘low contrast’ modified landscapes that are likely to provide critical habitat for species of conservation concern. This was delivered in three main steps.

1. Determine the specific habitat types whose structure, function and dynamics can potentially be mimicked within modified landscapes. This step again made use the Ecosystems of SA (Willoughby et al., 2021), SA Landcover (2010-2015), Land use 2020 (DEW, 2022) and SA Vegetation (DEW, 2023b) datasets.
2. Determine the specific land uses where mimicked habitat the structure, function and dynamics could persist. This step made use of the ACLUMP landuse dataset (DEW, 2020).
3. Combine the results of the previous two steps to identify those modified landscapes that are likely to provide habitat for species of concern, calculated as a percentage of the total available habitat per IBRA Subregion (the total of natural and modified landscapes that retain natural habitat character):
 - a. High Priority Landscapes – IBRA subregions where modified areas that retain natural habitat character comprise more than 30% of the total habitat
 - b. Moderate Priority Landscapes – IBRA subregions where modified areas that retain natural habitat character comprise more than 10% of the total habitat
 - c. Low Priority Landscapes – IBRA subregions where modified areas that retain natural habitat character comprise less than 10% of the total habitat

5.2.2 Results

Figure 5.2.2 presents a summary of IBRA Subregions containing modified landscapes with natural habitat character that can make a significant contribution to conservation by supporting species not well conserved within remnant habitats and formal protected areas. Table 5.2.2 presents a detailed breakdown of the results and percentage statistics. The high priority landscapes would be ideal candidates for OECMs as they are not recognised for the significant contribution they make to biodiversity conservation.

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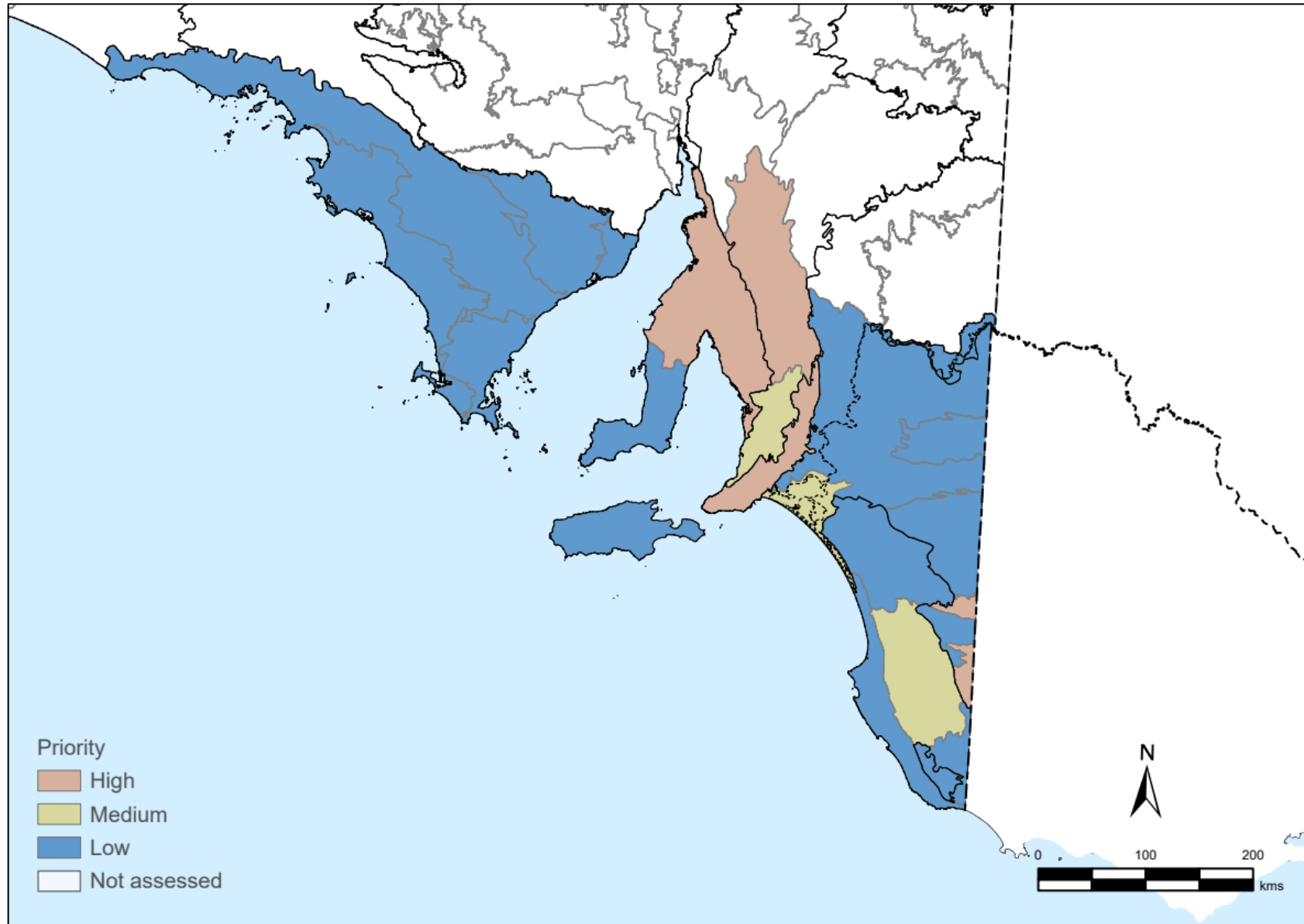


Figure 5.2.2: IBRA Subregions Containing Modified Landscapes with Natural Habitat Character within the South Australian Agricultural Zone

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Table 5.2.2: Modified landscapes with Natural Habitat Character summary statistics

IBRA Region Name	IBRA Region (hectares)	Percent of IBRA Region in SA	IBRA Region Protected (Percent)	IBRA Subregion Name	IBRA Subregion (hectares)	Percent of IBRA Subregion in SA	IBRA Subregion Protected (Percent)	Natural Habitat Character
Eyre Yorke Block	6,095,895	100	15.449	Southern Yorke	437,410	100	8.462	Not a Priority
				St Vincent	1,089,793	100	1.287	High Priority
				Eyre Hills	1,168,057	100	13.438	Not a Priority
				Talia	1,091,664	100	20.258	Not a Priority
				Eyre Mallee	2,308,971	100	22.2	Not a Priority
Flinders Lofty Block	6,587,005	100	9.159	Mount Lofty Ranges	299,880	100	5.846	Priority
				Broughton	1,028,758	100	0.519	High Priority
Kanmantoo	811,553	100	20.574	Kangaroo Island	441,502	100	34.483	Not a Priority
				Fleurieu	370,051	100	3.979	High Priority
Murray Darling Depression	19,905,388	28	19.374	Murray Mallee	5,027,247	42	14.14	Not a Priority
				Murray Lakes and Coorong	248,947	100	17.243	Priority
				Lowan Mallee	2,389,796	41	72.714	Not a Priority
				Wimmera	2,148,579	6	2.341	High Priority
Naracoorte Coastal Plain	2,464,767	83	9.803	Bridgewater	465,483	96	11.338	Not a Priority
				Glenelg Plain	557,651	28	12.689	Not a Priority
				Lucindale	733,612	100	4.2	Priority
				Tintinara	708,021	100	12.328	Not a Priority

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Riverina	9,686,022	2	5.855	Murray Scroll Belt	373,967	44	35.367	Not a Priority
Southern Volcanic Plain	2,454,220	3	2.196	Mount Gambier	84,645	100	2.996	Not a Priority

Further information

For more information, please contact DEW at DEW.Science@sa.gov.au or visit www.environment.sa.gov.au

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