



# The Australian Alps Icons and Threats MCAS-S datapack from the Landscapes and Policy Hub

## Manual

prepared by:

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2014

The Landscapes and Policy Research Hub is supported through funding from the Australian Government's National Environmental Research Program [www.environment.gov.au/nerp](http://www.environment.gov.au/nerp) and involves researchers from the University of Tasmania (UTAS), The Australian National University (ANU), Murdoch University, the Antarctic Climate & Ecosystems Cooperative Research Centre (ACE CRC), Griffith University and Charles Sturt University (CSU).



## The Australian Alps Icons and Threats MCAS-S datapack

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### Purpose of Report

The aim of this users' guide is to describe the spatial data in the datapack and provide instructions on how the layers can be analysed and explored in MCAS-S for decision support. The instructions take the form of a worked example. You will need to download and install MCAS-S software to your desktop or laptop. The worked example then steps you through using MCAS-S and how to open an MCAS-S package to combine layers. This guide is not intended to be a comprehensive guide to using MCAS-S. For more detailed information on how to use MCAS-S, including how to format spatial data for input to MCAS-S, please see the ABARES website – [www.abares.gov.au/mcass](http://www.abares.gov.au/mcass) and User Guide (ABARES 2014). The report is an output of the Landscapes and Policy Research Hub. The report is an output of the Landscapes and Policy Research Hub.

Please cite the report as follows:

**Porfirio L, Hugh S, Carter L & Mackey B (2014) The Australian Alps Icons and Threats MCAS-S datapack. Landscapes and Policy Hub, Hobart, Tasmania.**

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### Acknowledgements

The report is an output from the Landscapes and Policy Research Hub. The hub is supported through funding from the Australian Government's National Environmental Research Program and involves researchers from the University of Tasmania (UTAS), The Australian National University (ANU), Murdoch University, the Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC), Griffith University and Charles Sturt University (CSU).

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## Glossary

<b>ABARES</b>	Australian Bureau of Agriculture and Resource Economics and Sciences
<b>ArcGIS</b>	Software produced by ESRI that enables spatial data to be generated, analysed, manipulated, stored and managed
<b>Composite data layer in MCAS-S</b>	Any layer that combines data from more than one layer
<b>EVC</b>	Ecological Vegetation Class, part of the vegetation classification system used by the Victorian government
<b>GIS</b>	Geographic Information Systems are tools used to capture, store, manipulate, analyse and manage spatial data
<b>IBRA</b>	Interim Biogeographic Regionalisation for Australia, undertaken by the federal Department of the Environment
<b>IBRA Alps bioregion</b>	Australian Alps Bioregion classified by IBRA but not corresponding to the Australian Alps National Parks
<b>Information Panel</b>	Left-hand panel in MCAS-S used to edit maps
<b>Input layer</b>	Data layer contained within the primary folder of an MCAS-S project
<b>LaP</b>	Landscapes and Policy Hub
<b>Mask</b>	A type of data layer used in MCAS-S to restrict analyses to a defined area
<b>MCAS-S</b>	The Multi-Criteria Analysis Shell for Spatial Decision Support is a decision support tool designed specifically for non-GIS users to integrate spatial data
<b>MCAS-S datapack</b>	A series of folders and data layers organised and formatted ready for use in an MCAS-S project
<b>Multi-way map</b>	A composite map layer created using the multi-way function to combine more than two input layers
<b>NERP</b>	National Environmental Research Program, funded by the Australian Government
<b>Overlay</b>	A data layer used in MCAS-S as a visual reference, which does not influence any calculations occurring in composite maps
<b>P4</b>	Project 4 within LaP, also known as the Bioregional Futures Project
<b>The Australian Alps</b>	Corresponds to the area covered by Australian Alps National Parks, used here as the study area
<b>Tip file</b>	A short metadata record used to describe data layers exported from MCAS-S
<b>Two-way map</b>	A composite map layer created using the two-way function to combine two input layers
<b>Viewer window</b>	A pop-up window within in MCAS-S that shows the value of a pixel in a map plus values of all input layers to that map upon mouse hover over the pixel of interest. The viewer opens by default but if closed can be opened via the Edit tab.

# 1. Introduction to the Australian Alps Icons and Threats MCAS-S datapack

## 1.1 The Australian Alps

The Australian Alps is a region of low mountains stretching some 375 km from Mount Baw Baw in Victoria to southern New South Wales (NSW) and the western margins of the Australian Capital Territory (ACT). The Australian Alps Bioregion as defined by the Interim Biogeographic Regionalisation for Australia (IBRA) covers around 1.2 million hectares, with more than 60% of this area protected under The National Parks Act. The Australian Alps National Parks network overlaps but differs from the IBRA region (Figure 1). It includes eleven protected areas spanning 2.6 million hectares that cross the borders of Victoria, NSW & the ACT. For this exercise, we have focussed our analyses on the area that falls with The Australian Alps National Parks network (known here as The Australian Alps).

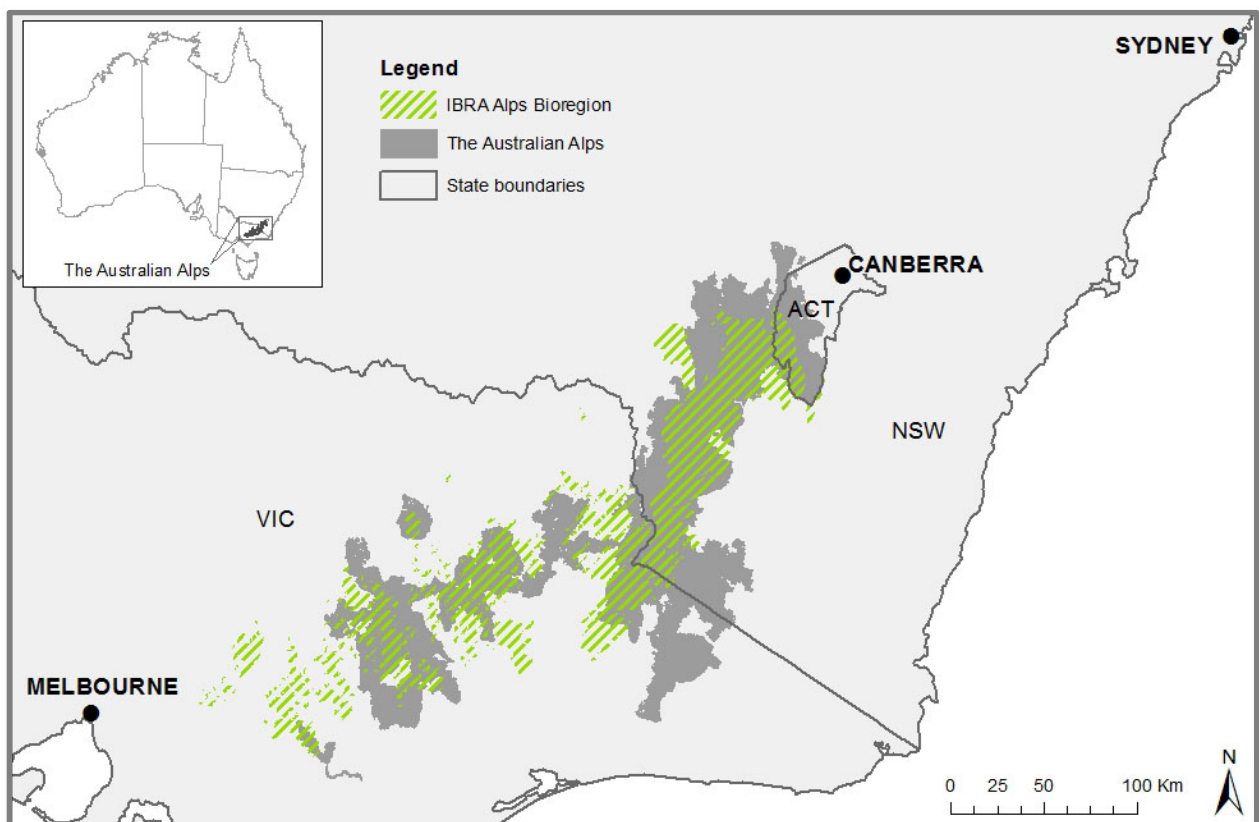


Figure 1: The Australian Alps and the IBRA Alps Bioregion

The Australian Alps is a large, complex and diverse landscape with thousands of sites of significance spreading across three state borders. Each state and territory agency manages the area directly under its jurisdiction. While there is a cooperative management program in place between the three states and the Commonwealth governments, there has been no common dataset or information system on which to undertake Alps-wide analysis and conservation planning (the exception is a catchment condition report (Worboys & Good 2011) that used a common standard and index for assessing sub-catchment condition across the landscape). While cooperation is achieved through dialogue, strategic assessment of values and threats across the landscape is limited by the three different environmental management systems and datasets.

Here we present a new strategic approach to understanding the key icons and threats to iconic values across the alps region based on a common, alps-wide data set and the MCAS-S decision support tool. This approach, we believe, provides information in ways that are meaningful for park managers and other stakeholders. The major landscape values of the Australian Alps were revealed through identifying seven iconic features that best represent their intrinsic character. Nine key known threats to those features were identified and an index of catchment condition was used to determine their current state. For this exercise, we generated MCAS-S spatial data layers for each of the icons and threats.

### 1.2 The MCAS-S Tool

The Multi-Criteria Analysis Shell for Spatial Decision Support (MCAS-S), developed by Dr Rob Lesslie and colleagues at the Australian Bureau of Agricultural and Resource Economics and Sciences (Lesslie et al. 2008), is a decision support tool designed specifically for non-GIS users to easily explore spatial data and apply them to natural resource management and planning problems.

The tool is free and users require little training to analyse spatial data and assess the results. MCAS-S allows people with different levels of technical and scientific expertise to easily and interactively interrogate and analyse spatial data, answer ‘what if’ questions, and build scenarios that map the implications of different conservation management interventions. MCAS-S has the potential to be a very useful tool for ecological management because a range of spatial data can be easily integrated to explore potential futures or the effects of management decisions, particularly in workshop situations when data may be incomplete and decision-making is by consensus. Here we show how this tool can be used to visualise and explore spatial variability in icons and threats to those iconic values, across the Australian Alps National Parks network.

### 1.3 The Australian Alps icons and threats MCAS-S datapack and tutorial

This users’ guide and data package includes an MCAS-S datapack which contains spatial data for each of the identified seven icons and nine threats across the study region, plus supporting data layers such as state boundaries. The datapack consists of MCAS-S formatted spatial data and sample MCAS-S project files that illustrate how the data can be combined to support decision-making. The MCAS-S approach allows managers to pinpoint areas of highest iconic value under different types and levels of threat. The datapack also provides the basis for managers to work



collaboratively across jurisdictions and take a landscape-scale approach to prioritising decisions about allocation of resources to target, for example, iconic sites under greatest threat.

The aim of this tutorial is to describe the spatial data in the datapack and provide instructions on how the layers can be analysed and explored in MCAS-S for decision support. The instructions take the form of a worked example. You will need to download and install MCAS-S software to your desktop or laptop. The worked example then steps you through using MCAS-S and how to open an MCAS-S package to combine layers. This tutorial is not intended to be a comprehensive guide to using MCAS-S. For more detailed information on how to use MCAS-S, including how to format spatial data for input to MCAS-S, please see the ABARES website – [www.abares.gov.au/mcass](http://www.abares.gov.au/mcass) and User Guide (MCAS-S development partnership 2014).

### Installing MCAS-S Software

To use the datapack, you need to download and install the free MCAS-S software (ABARES 2014) onto your Windows computer.

1. Go to MCAS-S home page: [www.abares.gov.au/mcass](http://www.abares.gov.au/mcass)
2. Go to the right-hand side menu and click on **MCAS-S Tool**
3. A new page opens with two download options –
  - a. MCAS-S Version 3.1 installer (150MB) – takes about 10mins
  - b. MCAS-S Version 3.1 user guide (10MB)
4. Download the installer (arrives zipped) then unzip – takes about 10mins. If you are new to MCAS-S, also download the MCAS-S user guide.
5. Once downloaded, follow prompts to install (requires ‘Quicktime’ to also be installed)
6. Register as a user

### Unzip the MCAS-S Datapack

Before you start playing with our worked example, the next step is to extract the datapack from its zipped folder (right-click and unzip to you). If the datapack isn’t unzipped correctly, MCAS-S will not be able to upload the spatial data and a red cross will appear in each map box instead of a map.

**Now you are right to go!**

## 2. Worked example: Mapping icons and threats in the Australian Alps National Park network

### 2.1. About the worked example

This worked example guides you through how you might use MCAS-S to consider a query for mapping icons and threats in the Australian Alps. We provide background information about the issue, sketch out the essential ‘means-to-end’ diagram, and then take you through a data combining exercise.

### 2.2. Icons

The Australian Alps national parks are varied and rich in biodiversity values with thousands of sites recording listed species. However, vegetation classifications and listed species schedules are recorded using state based systems that use differing standards and criteria. The exception is NSW and the ACT, which share a vegetation classification system. Management plans for the individual parks take a varied approach to identifying and categorising values and there is no strategic assessment of focal values.

To address these issues, we developed a system that combines existing data from state and federal government agencies, and university researchers across the Australian Alps landscape. We were able to further analyse some of these datasets and drew upon expert knowledge to produce new attributes and information at the regional scale.

Icons were determined by identifying natural features that best embody the key values and characteristics of the Australian Alps landscape. A set of iconic natural features were proposed by the Landscapes and Policy Hub (LaP) to enable protected area agency staff and key stakeholders to be surveyed online, to test whether they agreed or not with these features, to prioritize their importance and to seek other suggestions. This qualitative approach resulted in the identification of seven iconic natural features, known here as icons (see list of icons in Table 1).

### 2.3. Common vegetation classification

Fundamental information for biodiversity conservation is a map of native vegetation cover showing the composition and structure of major plant classes. While vegetation maps have been produced by the state governments of NSW, Victoria and ACT, no common classification or map exists that recognises the special ecosystem types of the alps. To fill this gap, we developed a common vegetation classification and generated a new map for the Australian Alps by integrating the Victorian vegetation classification system with the NSW/ACT system. We did this by matching 58 NSW/ACT Vegetation Groups with 68 Victorian ecological vegetation classes to produce 18 new vegetation classes. The new classification and map provide a common cross-jurisdictional approach to identifying the distinctive vegetation types of the alps.



## 2.4. Threats

There is a shared understanding of key threats across jurisdictions, however there is no common system for recording threat presence and treatments, which limits a strategic approach to threat management.

LaP identified a set of key threats to the alps landscape icons. Protected area agency staff and key stakeholders were surveyed online, to test whether they agreed or not with these threats, to prioritise their importance and to seek other suggestions. The responses were cross-checked against Victoria's State of the Parks Report (Parks Victoria 2007) to validate the match against previous staff surveys. This qualitative approach resulted in the identification of nine key threats (see Table 1). Agency data on the presence and treatment of the threats was then gathered and assimilated into the MCAS-S datapack.

## 2.5. Catchment condition

A catchment condition index and map, derived from the 'Caring for our Australian Alps Catchments' report (Worboys and Good 2011), was used to describe current condition and likely trends in condition. The map uses a common standard and index for assessing sub-catchment condition across the landscape. A number of the catchments cross state boundaries and were given different condition and trend scores by the relevant state government agencies. In this instance, any catchment that crosses a state boundary has been cut along that boundary and the relevant agency score applied to reflect differences in land management that has resulted in variability in condition on either side of the state border.

## 2.6. Heritage rivers

Rivers have shaped the iconic natural and cultural landscape of the Australian Alps today and are the lifeblood of the giant Murray-Darling, Murrumbidgee Irrigation and Snowy Hydro-electricity systems. Heritage Rivers are those that have significant nature conservation, recreation, scenic or cultural heritage attributes. The Victorian Government passed the *Heritage Rivers Act 1992* to provide protection of public land around rivers and within catchments that have these significant values. As part of the process, they developed a GIS layer to highlight rivers identified with such values. No corresponding dataset was available for NSW or ACT, so we derived an equivalent GIS layer using expert opinion and values assessment and linked it with the Victorian data to create a cross-jurisdictional dataset.

## 2.7. Aim

The MCAS-S datapack can be used to help determine management priorities for both natural values and threats and to consider the interaction between multiple variables. It also provides the basis for managers to work collaboratively across jurisdictions and to take a landscape-scale approach to prioritising decisions around allocation of resources.

## 2.8. Data for the worked example

A complete list of the data available for this analysis is shown in Table 1. The data are grouped into three types:

1. Icons
2. Threats
3. Supporting data

Unless specified, icons and threats contain data combined from three sources: Parks Victoria, NSW NPWS and the ACT Parks and Conservation Service. When combining cross-jurisdictional data into a single layer, difficulties can arise due to differences in the types of data collected and naming protocols. Metadata specifying the methods used to merge the various datasets is in progress.

The types of spatial data considered for the analysis included vector and raster data. MCAS-S requires all data for analysis to be in raster format so other data types (vector, point and polygon) were converted (ie rasterised). Threat data invariably comes in the form of point locations where an animal or weed has been sighted or treated during a particular survey. Prior to conversion, data observation points for individual threat animals were buffered by 5 km to account for species movement and weeds were buffered by 1 km (if needed, other relevant buffering distances could be calculated using the raw point data directly in MCAS-S).

The data values in this worked example are in binary format. Values of '1' were given to grid cells that meet the criteria, for example presence of feral animals or weeds. 'NoData' values were used for grid cells that do not meet the criteria. Justification for each criterion is provided in Table 1.

Table 1: Primary input layers available for mapping icons and threats in The Australian Alps

Data layer	Type	Source	Description	Criteria	Justification
Alpine peaks	Icon	Derived. Created by Bioregional Futures (LaP P4) in consultation with Peter Jacobs.	High summit alpine peaks selected from topographic maps & mapped using contours derived from 1 second DEM (Geoscience Australia 2011)	Selected treeless peaks above 1550m	Identified as an icon during survey process; criteria based on expert knowledge by Peter Jacobs & Gillian Anderson
Treeless high plains & frost hollows	Icon	Combined Alps Vegetation dataset. Created by LaP P4 in consultation with Peter Jacobs.	The high plains are expansive and treeless flat to undulating features at higher elevations, snow covered in winter and spring. Selected vegetation types from Victorian & NSW/ACT Vegetation layers	Relevant NSW vegetation groups and Victorian EVCs	Identified as an icon during survey process; criteria based on expert knowledge by Peter Jacobs & Gillian Anderson
Alpine wetlands & bogs	Icon	VIC, NSW and ACT Parks	The Alpine Wetlands are bogs and peatlands that occur in high altitude wetlands and waterways at the tops of water catchments. They were identified from vegetation layers & aerial photos		Identified as an icon during survey process; criteria based on expert knowledge by Peter Jacobs & Gillian Anderson
Sub-alpine woodlands	Icon	Combined Alps Vegetation dataset. Created by LaP P4 in consultation with Peter Jacobs.	Snow Gum woodlands ( Dominated by <i>Eucalyptus pauciflora</i> ) cover vast areas at the highest elevations that trees can grow. Selected vegetation types from Victorian & NSW/ACT Vegetation layers	Relevant NSW vegetation groups and Victorian EVCs	Identified as an icon during survey process; criteria based on expert knowledge by Peter Jacobs & Gillian Anderson
Tall wet forests	Icon	Combined Alps Vegetation dataset. Created by LaP P4 in consultation with Peter Jacobs.	The Tall Wet Forests dominate the mid to higher elevations across the alps where suitable aspect, soil and rainfall contribute to growth of forests dominated by Alpine Ash ( <i>Eucalyptus delegatensis</i> ), and to a lesser extent, Mountain Ash. Selected vegetation types from Victorian & NSW/ACT Vegetation layers	Relevant NSW vegetation groups and Victorian EVCs	Identified as an icon during survey process; criteria based on expert knowledge by Peter Jacobs & Gillian Anderson
Rain-shadow woodlands	Icon	Combined Alps Vegetation dataset. Created by LaP P4 in consultation with Peter Jacobs.	The rainshadow woodlands occur in the upper Snowy River Valley where the high Main Range blocks prevailing moisture, causing a rainshadow effect. Determined from topographic maps and vegetation classes	Relevant NSW vegetation groups and Victorian EVCs	Identified as an icon during survey process; criteria based on expert knowledge by Peter Jacobs & Gillian Anderson
Heritage Rivers	Icon	Victorian Heritage Rivers data. Derived from Geofabric v2.1.	Rivers that have significant nature conservation, recreation, scenic or cultural heritage attributes. NSW and ACT equivalent were created by LaP P4 in consultation with Peter Jacobs. (Bureau of Meteorology 2012)		Rivers have shaped the iconic natural and cultural landscape of the Australian alps today and are the lifeblood of the giant Murray Darling, Murrumbidgee Irrigation and Snowy Hydro-electricity systems
Horses density	Threat	Dan Brown – Parks Victoria	Density of feral horses ( <i>Equus caballus</i> ) in VIC national parks. Layer based on survey data.	Victoria only	Identified as a key threat during survey process
Horses	Threat	NSW agency data and Atlas of Living Australia	Locations where feral horses ( <i>Equus caballus</i> ) have been observed; buffered point data	3 states -9999 = No data -888 = Area searched and no horses observed 1 = Area searched and horses observed	Identified as a key threat during survey process



<b>Deer</b>	Threat	VIC, NSW and ACT Parks	Locations where deer (various species) have been observed; buffered point data	3 states -9999 = No data -888 = Area searched and no deer observed 1 = Area searched and deer observed	Identified as a key threat during survey process
<b>Pigs</b>	Threat	VIC, NSW and ACT Parks	Locations where pigs ( <i>Sus scrofa</i> ) have been observed; buffered point data	3 states -9999 = No data -888 = Area searched and no pigs observed 1 = Area searched and pigs observed	Identified as a key threat during survey process
<b>Foxes</b>	Threat	VIC, NSW and ACT Parks	Locations where foxes ( <i>Vulpes vulpes</i> ) have been observed; buffered point data	3 states -9999 = No data -888 = Area searched and no foxes observed 1 = Area searched and foxes observed	Identified as a key threat during survey process
<b>English broom</b>	Threat	VIC, NSW and ACT Parks	Locations where English broom ( <i>Cytisus spp</i> ) has been identified and usually controlled; buffered point data	3 states -9999 = No data -888 = Area searched and no broom observed 1 = Area searched and broom observed	Identified as a key threat during survey process
<b>Hawkweeds</b>	Threat	VIC, NSW and ACT Parks	Locations where hawkweeds ( <i>Hieracium spp</i> ) have been identified and usually controlled; buffered point data	3 states -9999 = No data -888 = Area searched and no hawkweed observed 1 = Area searched and hawkweed observed	Identified as a key threat during survey process
<b>Willows</b>	Threat	VIC, NSW and ACT Parks	Locations where willows (various species) have been identified and usually controlled; buffered point data	3 states -9999 = No data -888 = Area searched and no willows observed 1 = Area searched and willows observed	Identified as a key threat during survey process
<b>Blackberry</b>	Threat	VIC, NSW and ACT Parks	Locations where blackberry ( <i>Rubus fruticosus agg.</i> ) has been identified and usually controlled; buffered point data	3 states -9999 = No data -888 = Area searched and no blackberries observed 1 = Area searched and blackberries observed	Identified as a key threat during survey process
<b>Ox-eye Daisy</b>	Threat	VIC, NSW and ACT Parks	Locations where ox-eye daisy ( <i>Leucanthemum vulgare</i> ) has been identified and usually controlled ; buffered point data	3 states -9999 = No data -888 = Area searched and no ox-eye daisy observed 1 = Area searched and ox-eye daisy observed	Identified as a key threat during survey process
<b>Alps fire frequency</b>	Fire frequency from 2000-2012	Data processed by LaP P4, monthly satellite data from LaP Vegetation and Fire project, satellite data from AusCover web portal	Fire frequency for the period 2000-2012 based on MODIS satellite data, MCD64A1 product (NASA).	pixels denote number of times burnt in the study period.	Alpine areas that have been previously burnt or are in burnt country are more vulnerable to impacts from climate change and invasive species.

<b>Catchment Condition</b>	Overlay	(DECCW NSW 2010)	2 separate layers; Catchment condition status & trend in condition status		Assessment undertaken by NSW DECCW
<b>Combined Alps Vegetation</b>	Vegetation	Derived. Created by LaP P4 in consultation with Peter Jacobs.	Broad vegetation groups (n=18) Created using Victorian EVC data (DEPI 2005) and NSW/ACT data from (Gellie 2005)		
<b>Australian Alps National Parks</b>	Overlay	Department of the Environment	Relevant Parks selected from the Commonwealth & Protected Areas Database (CAPAD) 2012	n.a.	n.a.
<b>Major rivers</b>	Overlay	Bureau of Meteorology, Geofabric	Useful to see if weed species are clustering around waterways. Also used to get distance to/from rivers.	n.a.	n.a.
<b>Place names</b>	Overlay	Geoscience Australia GEODATA TOPO 250K Series 3	Useful for spatial location and determining distances to/from population centres	n.a.	n.a.
<b>Populated places</b>	Overlay	Geoscience Australia GEODATA TOPO 250K Series 3	Useful for spatial location and determining distances to/from population centres	n.a.	n.a.
<b>Primary Roads</b>	Overlay	Geoscience Australia GEODATA TOPO 250K Series 3	Useful for spatial location and could be buffered to look at potential impact of roads on icons & threats	n.a.	n.a.
<b>Ski resorts</b>	Overlay	Geoscience Australia GEODATA TOPO 250K Series 3	May be useful for spatial location and determining distances to/from areas with high recreation use	n.a.	n.a.
<b>States</b>	Overlay	Geoscience Australia GEODATA TOPO 250K Series 3	Useful for reporting by state	n.a.	n.a.
<b>Walking tracks</b>	Overlay	Geoscience Australia GEODATA TOPO 250K Series 3	Useful for spatial location and could be buffered to look at potential impact of tracks on icons & threats	n.a.	n.a.
<b>Waterbodies</b>	Overlay	Geoscience Australia GEODATA TOPO 250K Series 3	May be useful for spatial location	n.a.	n.a.

## 2.9. Means-to-end diagram

The means-to-end diagram illustrated in Figure 2 shows how the data were combined in the MCAS-S example to explore spatial variability in threats to iconic natural values. For other projects, we strongly recommend developing a means-to-end diagram prior to getting data into MCAS-S. This will ensure that the model structure is appropriate to the project aims and for the required data to be identified, formatted and entered into the datapack. Within MCAS-S each of the boxes in Figure 2 is a stand-alone spatial data layer (ie map). Each MCAS-S layer can also be exported to a GIS such as ArcGIS or Google Earth™ or saved as an image.

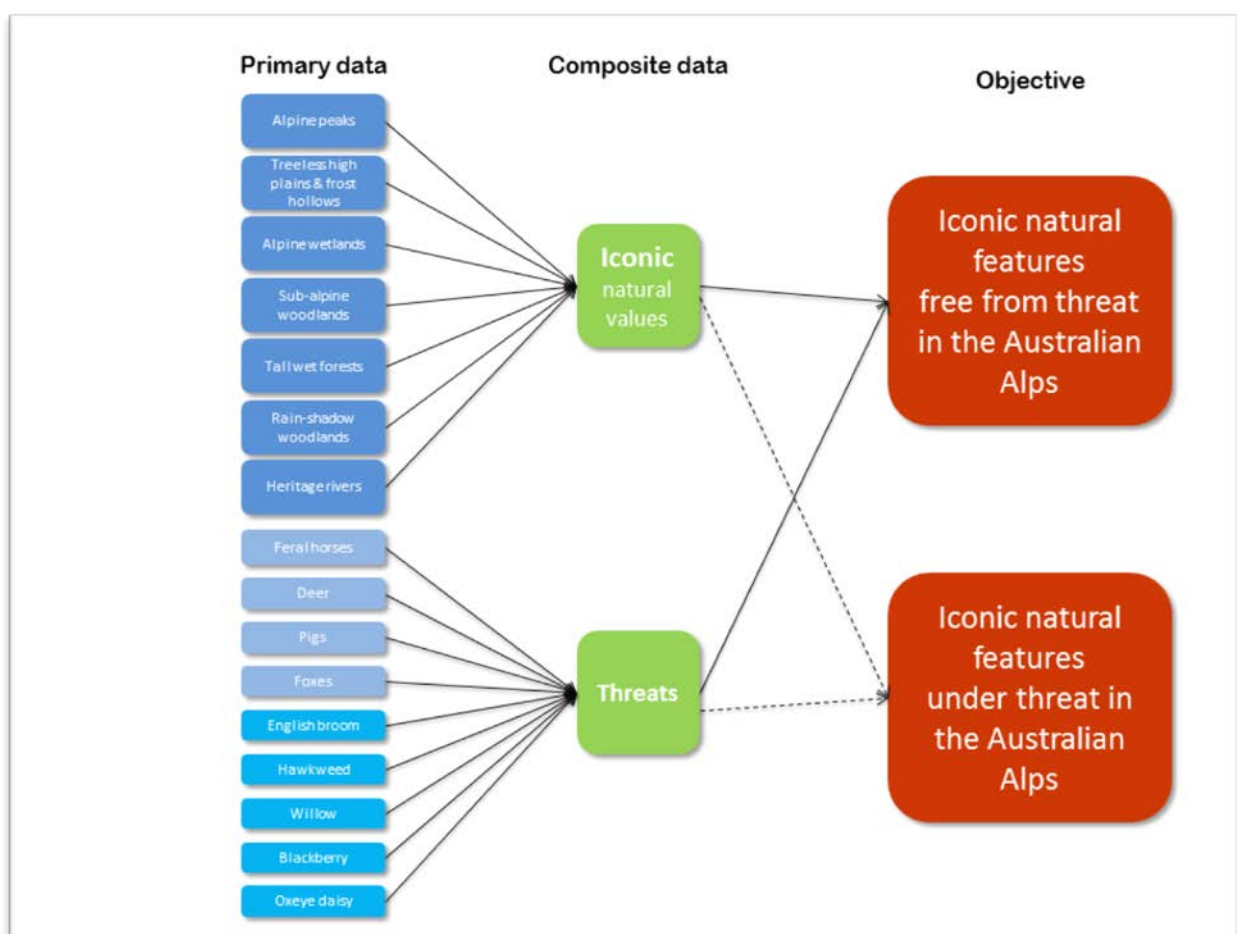


Figure 2: Means-to-end diagram for the Alps icons and threats model, analysis and datapack. Blue boxes represent primary input layers and all other boxes represent different levels of spatial integration. The red boxes represent two possible final composite products: the location of iconic natural features relatively free from threats; and the location of iconic natural features under threat.

## 2.10. MCAS-S package structure

The Australian Alps natural values and threats MCAS-S datapack consists of two MCAS-S project files and a set of three MCAS-S data folders. The project files are:

**Alps\_Icons\_Threats.mcas** contains the completed worked example described in this document.

**Alps\_Icons\_Threats\_blank.mcas** contains links to the data used in the worked example but the workspace is blank so that users can select and combine the layers from scratch.

The three data folders are Data, History and KML (see Table 2). The ‘Data’ folder contains all of the base layers necessary for the Australian Alps icons and threats analysis. The ‘Data’ folder includes four sub-folders: Primary, Classified, Overlay and Mask. Most of the base data layers for this analysis are located in the Primary sub-folder. We have also added some useful overlays and masks to their respective sub-folders. Some folders are initially empty but these should not be deleted as MCAS-S will write to these folders for various operations.

*Table 2: MCAS-S folder structure and descriptions (adapted from MCAS-S user-guide V3.1 2014)*

Level 1	Level 2	Description
Data	Primary	Gridded base layers for each natural value or threat
	Classified	Gridded data exported from MCAS-S by user (initially empty)
	Overlay	Line or point data used for visual reference only: National Park boundaries, state borders
	Mask	Gridded data used to restrict the area of analysis: The Australian Alps National Parks
History		Cached project files (initially empty)
KML		GoogleEarth™ (*.kml) files exported from MCAS-S (initially empty)

### 3. Worked example instructions

To gain the most from the worked example, open the MCAS-S file in your unzipped folder, and follow what we do in the text by having a play on the MCAS-S screen.

Open the file: [Alps\\_Icons\\_Threats.mcas](#)

#### 3.1. Primary input data

The file [Alps\\_Icons\\_Threats.mcas](#) contains a worked example using most of the primary input datasets provided in the Australian Alps Icons and Threats MCAS-S datapack (Figure 3). This worked example is based on the model structure shown in the means-to-end diagram in Figure 2.

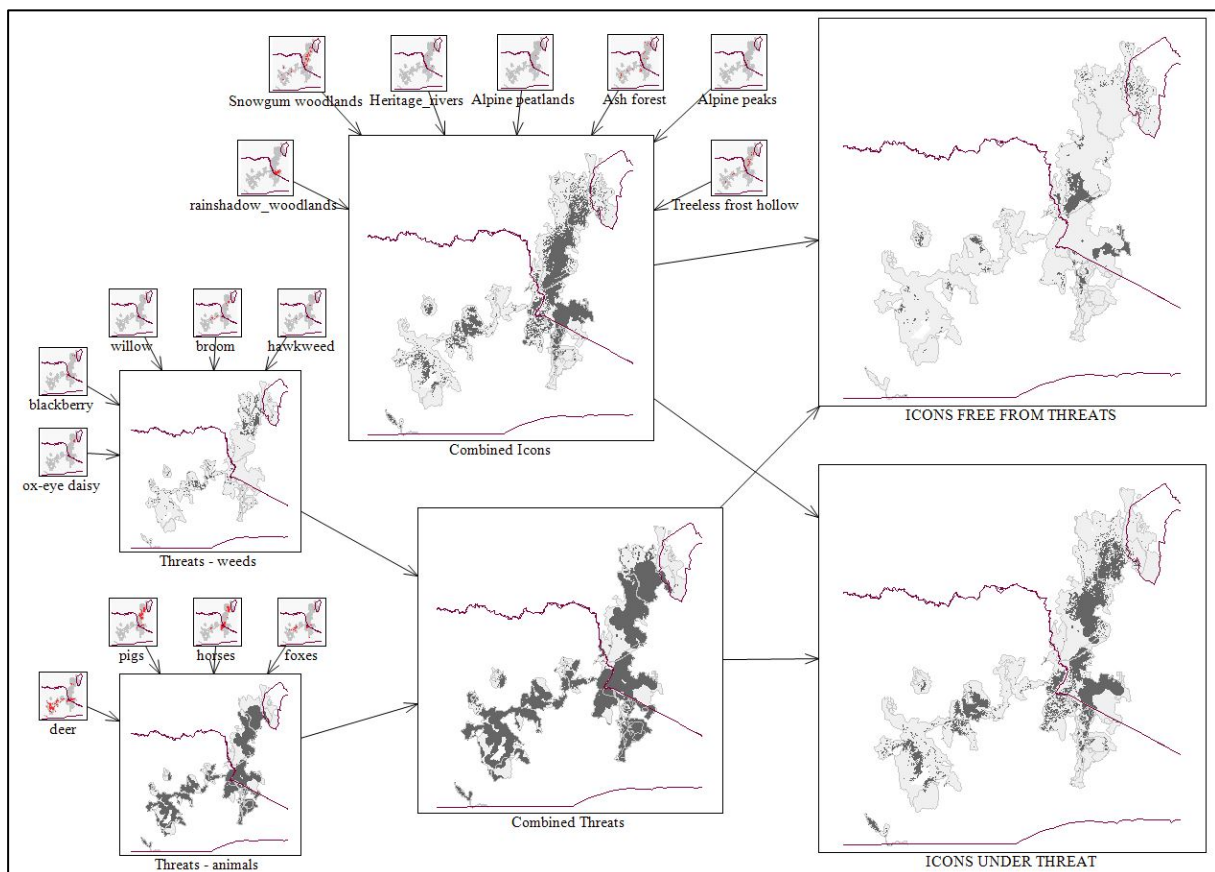


Figure 3: The structure of the Australian Alps icons and threats MCAS-S model. Red indicates areas that meet icon or threat criteria values (Table 1). Composite layers are monochrome with dark grey indicating areas that meet the criteria.

The primary input layers are the smallest maps shown and each has two categories: 'NoData' (light grey) for areas that have no natural value or presence of threats and '1' (red) for areas that do contain icons or threat species. To zoom into a layer you have three options: change the



interface magnification (first option on map menu bar above the right-hand side workspace, double click on a map (Esc to exit), or right click and then select ‘Show in Google Earth’. Familiarise yourself with the different input layers by clicking on each individually and then viewing information about the data in the left-hand information panel. At this point it will also be useful to review the information about the different input layers in Table 1.

### 3.2. Composite data

Any output that combines data from more than one layer is a composite or integrated layer. There are several options within MCAS-S for integrating layers. Details for how to alter these options can be found in the MCAS-S User Guide (2014 -Section 6: Explore and Combine data).

There are six composite layers in this worked example:

1. Combined Icons
2. Threats – weeds
3. Threats – animals
4. Combined threats
5. Icons free from threats
6. Icons under threat

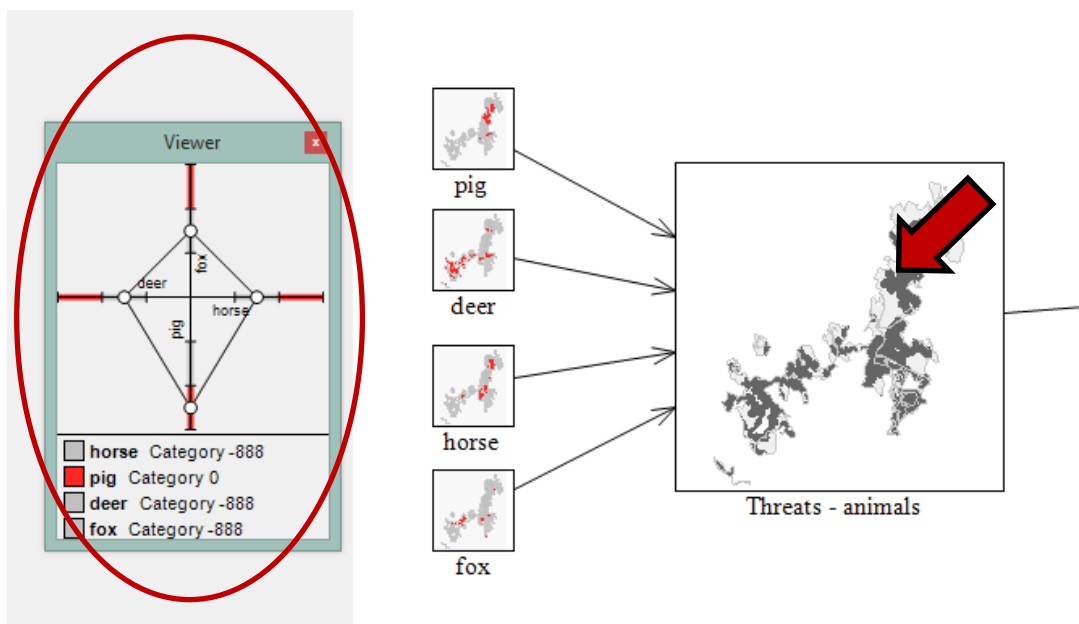


Figure 4: Viewer window in MCAS-S showing values of a pixel in the ‘Threats – animals’ composite layer

In this worked example, we used the ‘multi-way’ composite to integrate all of the data layers. All inputs are of equal weighting and areas within each layer that meet the criteria are masked and shown in dark grey (Figure 3). To view or modify how layers have been combined, click on the composite layer and view/change information in the information panel. Within MCAS-S, a mouse

hover over a pixel of interest on a composite layer will result in the viewer window displaying the names and pixel values for each of the input layers that influence the selected integrated map (Figure 4). If the viewer window is not visible, go to Edit>show viewer.

As the primary input data to the 'Combined Icons' layer contain discrete ecological communities, there is little overlap of icons apart from where alpine peaks overlap with treeless frost hollows.

In comparison, there can be more than one and up to five threats in any given location in the composite threats layer, which is indicated by the colour intensity when the map is viewed as a function of coincidence count, rather than as a mask. The intermediate composite layer 'Threats – weeds' indicates the isolated nature of the weed data, with clusters often forming along waterways. When utilising all of the four feral animal species, the 'Threats – animals' layer encompasses a large proportion of the alps, possibly as a result of the 5km point buffers.

When the icon and threat composites are combined into the final layers, areas containing icons that are relatively free from threats are highlighted. This is achieved by adjusting the weightings on the multi-way map (drag little white circles in the axis of the multi-way chart) to exclude areas where threats occur (Figure 5).

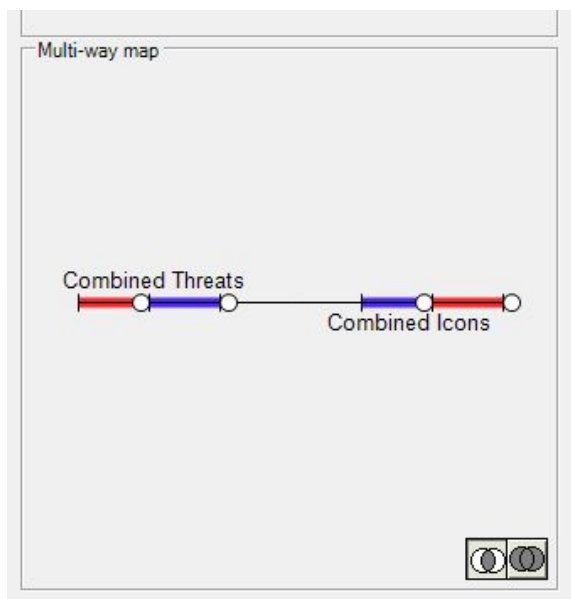


Figure 5: Multi-way map chart where circles along the axis can be adjusted to apply a mask.

A likely modification to this worked example would be to change the 'multi-way' maps to 'composite' maps, to allow weightings to be added for individual primary data layers. For example, some weeds may be more 'important' in terms of their negative impacts on the alpine environment than others, so they could be ranked in MCAS-S based on expert knowledge. More information about how to add weightings to composite layers can be found in the MCAS-S user guide (MCAS-S development partnership, 2014).



### 3.3. Modifying primary and composite data layers

Clicking on any layer within the worked example will show details about the layer in the left-hand information panel. Many of the options within this panel can be altered including the layer name, colour scheme, the number and colour of classes and the names of the categories or classes within each layer.

Other ways of modifying results are to:

- Delete layers - Right click, then delete. Note you cannot undo a delete! You'll need to drag the map back in from the Primary Input Data tab if you make an error.
- Change the input layers for an existing composite data layer - Modify connections by changing the input layers on the information panel or by modifying how the layers are integrated (e.g. by creating a 'Composite' map using this option on the Map menu bar (instead of a Two-Way or 'Multi-Way) and selecting and completing either 'Manual', 'Function' or 'AHP weighting' options to combine layers.
- Add layers from the primary folder - Click and drag layers from the 'Primary Input Data' tab.
- Create new integrated layers - Click and drag from either the 'Composite', 'Two-Way', 'Reclass' or 'Multi-Way' tabs to create a new blank map. Create connections by selecting input layers on the Information Panel.

### 3.4. Overlays and masks

The Australian Alps Icons and Threats datapack contains a number of overlay and mask files.

Overlays added to the maps are displayed on screen primarily as a useful visual reference, as they do not influence the calculations occurring in the model. Any line or point data can be added to the overlay folder and viewed in MCAS-S, however it is important to have the same projection as the raster layers in the current datapack. The overlays included here are:

- National park boundaries
- State boundaries
- Rivers, including a subset of heritage rivers
- Main roads and walking tracks
- Waterbodies, such as lakes and reservoirs
- Point locations of towns, populated places and ski resorts

Several mask layers have been included in the datapack:

- Alps national park boundaries
- State boundaries
- Catchment condition status
- Catchment condition trend

Masks can be used to analyse data within a specific area. The 'alps\_national\_park-9999' mask extends to the full extent of the workspace, essentially zooming in to the Australian Alps national parks. When selecting another mask, such as 'poor' in the catch\_condn\_status mask, results and any further analyses are restricted to the area that corresponds as 'poor'. To add/remove a mask—select the 'Mask' tab on the Map menu bar and then check/uncheck the relevant box.

### 3.5. Reporting

MCAS-S gives the option to generate reports using the 'Reporting' tool. The reports give, for example, the total number of hectares in a selected region where the criteria are met. In this example we can determine the proportion of icons that are free from threats within each national park. To compile a report, right click on top of the map you are interested in and select reporting. In this example we will report on the 'Icons free from threats' composite layer. The Reporting window will appear and there you can select the reporting region, 'alps\_national\_park\_all\_1', and the type of report (Report as) we will use is proportion. All layers in this example have the same resolution, so any layer can be chosen and the result will be the same (Figure 6). A table will appear with the list of national parks and the number of cells that met the criteria (Figure 7).

Reports can be saved as \*.csv files and opened in a spreadsheet program for further analysis and data manipulation.

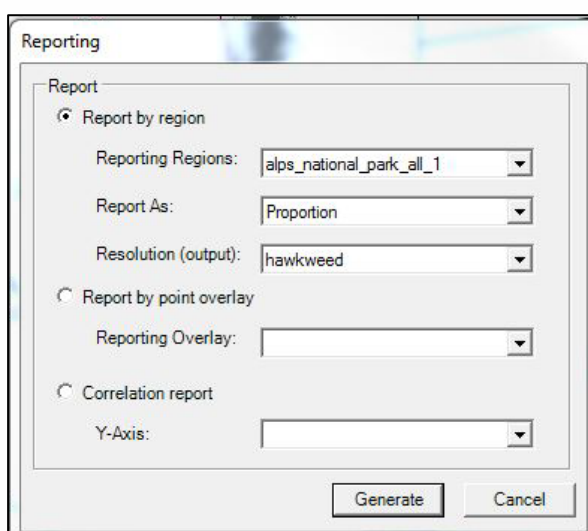


Figure 6: Reporting window

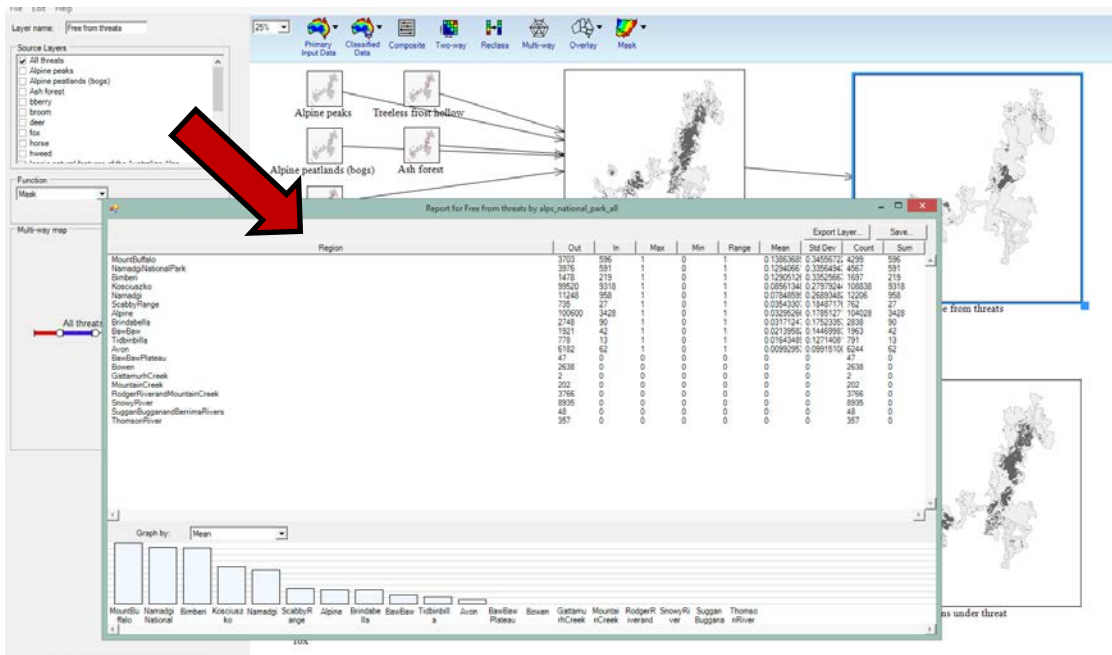


Figure 7: MCAS-S sample report.

### 3.6. Viewing results outside of MCAS-S

MCAS-S allows users to export layers for use in other applications. The available options for exporting are accessed via a right-click on the layer of interest and include:

1. Show in Google Earth: Note at time of publication there was a maximum resolution (1000\*1000 cells) for viewing MCAS-S layers in Google Earth™. Google Earth™ will render a lower resolution version that may not adequately represent fine scale data. To view files at the full resolution in Google Earth™ the user must export the layer from MCAS-S (see 3 below) and convert to \*.kml in an alternative application such as ArcGIS.
2. Save image: Allows you to save the map, legend and/or histogram of the layer of interest.
3. Export: Creates a GEOTIFF or ASCII file of the layer and saves it to the Data\Classified. This procedure requires the creation of a small metadata file known in MCAS-S as a tip file. See Appendix 10.2 for details on completing a tip file metadata record.

### 3.7. Modifying or creating new primary input layers

All of the primary input layers have been created from existing resources and converted to two-class datasets, according to the best available ecological information. Modifying or creating new

base layers will require some GIS expertise<sup>1</sup> and would need to be undertaken in a GIS-specific program such as ArcGIS.

### 3.8. Management conclusions from the worked example

Based on the best available data used in this example, the final composite indicates that the ACT has a greater proportion of icons most likely to be free from threats, followed closely by NSW and then Victoria. It is important to note that some of the alps area in the ACT may be considered sub-alpine so if such areas were excluded, the results would be different. We could expect an opposite result for icons under threat; however, the results showed that NSW has, in proportion, more icons under threat than Victoria and the ACT.

The comprehensive nature of the data provided in this worked example lends itself to further in-depth analyses that could be undertaken for the entire Australian Alps, by state or by individual national park. Users of this datapack are encouraged to create means-to-end diagrams to define an issue and determine the appropriate input variables needed to create meaningful outcomes.

We need to emphasise that these results are based on the primary data we used in the analysis. Including new or revised data may change the results. However, our main objective was to demonstrate how the MCAS-S tool can assist with determining management priorities for both icons and threats and to consider the interaction between multiple variables. This MCAS-S example for the icons and threats of the Australian Alps showed that data that have been collected from three different jurisdictions can be effectively used at the regional scale to inform management decisions.

## 4. Appendix

<i>Technical recommendations</i>	
<b>Extent</b>	All layers to be used in MCAS-S should have the same extent. In this case the extent for The Australian Alps is: Top: 6274792.61722; Left: 210374.568925; Right: 998166.45523; Bottom: 5788200.49867 (see projection below)
<b>Resolution</b>	Layers to be used in MCAS-S can have different grid cell resolutions; however, we recommend using the same resolution, in particular for beginners. The resolution used in this tutorial is approximately 250 x 250 metre pixels which simply reflects the scale at which some of the key data sets were available
<b>Projection</b>	All layers <b>must</b> have the same projection and we used GDA94 MGA Zone 55 South. This ensures all pixels (from north to south) are comparable in terms of area.
<b>Alps NoData</b>	Grid cells with missing data or where there are no data values within The Australian Alps were given a value of -888
<b>NoData</b>	Grid cells outside The Australian Alps, on land and in the ocean, were given a value of -9999. This is the number MCAS-S understands as “NoData” which means that these grid cells are displayed transparent.

## 5. References

- ABARES (2014) *MCAS-S Multi-Criteria Analysis Shell for Spatial Decision Support V3.1*, Department of Agriculture, Canberra.
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