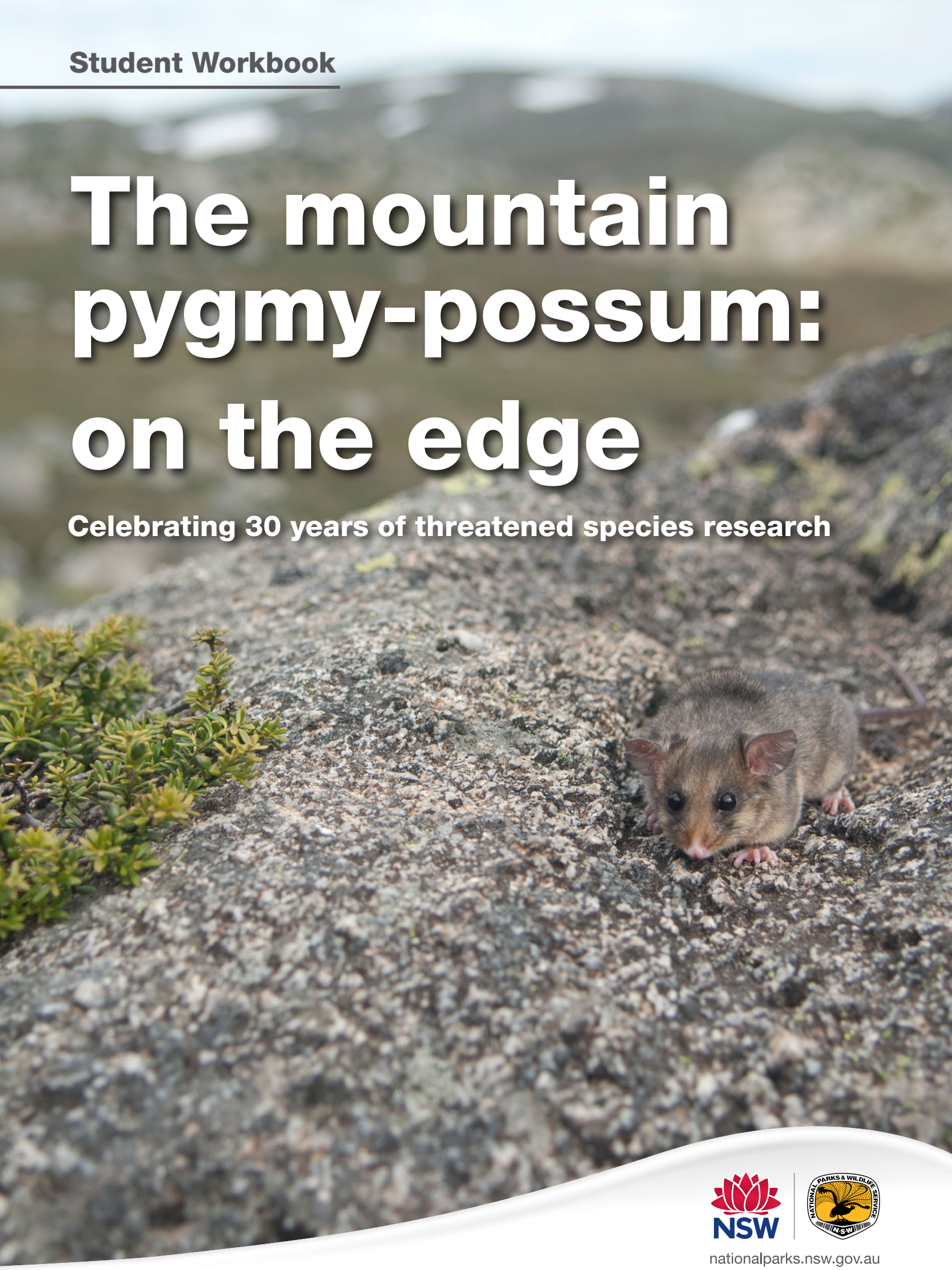
Student Workbook

The mountain pygmy-possum: on the edge

Celebrating 30 years of threatened species research



NSW National Parks & Wildlife Service

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Mountain pygmy-possum, Kosciuszko National Park. (Dan Nicholls)

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ABOUT THIS RESOURCE

This resource supports the study of:

- Biophysical Interactions (preliminary course)
- Ecosystems at Risk (HSC course)

The Geographical Information System (GIS) and Capture-Mark-Recapture (CMR) surveys are valuable geographical inquiry methodologies.

Students will learn to interpret visual data by using GIS to examine spatial and ecological issues relevant to the protection and management of ecosystems.

Biophysical Interactions

As part of a case study of biodiversity in the alpine environment.

Students will:

- identify geographical methods applicable to, and useful in the workplace
- be able to illustrate how an understanding of biophysical processes contributes to sustainable management in the environment.

The investigation will include:

- identification and explanation of the key biophysical processes which relate to the issue
- scale of operation
- interactions with other components of the biophysical environment
- the sensitivity of the biophysical environment to change
- the importance of understanding key biophysical processes for effective management

Ecosystems at Risk

The tasks may be integrated into the study of ecosystems and their management and could be part of an Alpine case study.

Students will:

- be able to identify geographical methods applicable to and useful in the workplace, such as constructing environmental maps and compiling environmental impact reports.
- understand the relevance of ecosystems at risk to a particular vocation such as managing a national park and guiding tourist groups as well as ecological mapping for research and cross government programs such as Saving Our Species.

Following these tasks, the students should discuss the methods, evaluate them and consider if the methods are justifiable.

Contact and feedback

We would be grateful to learn of any issues or challenges you may have using the resource and for any other feedback. If you have any questions please contact us via

Kosci.Education@environment.nsw.gov.au

Glossary

There is a glossary at the back of this reource. Look for the g within the document text.

Researchers investigating mountain pygmy-populations in Kosciuszko National Park (Linda Broome)

CONTENTS

Monitoring mountain pygmy-possums, Kosciuszko National Park. (Mel Schroder)

INTRODUCTION

The mountain pygmy-possum is an endangered Australian species restricted to alpine and sub-alpine environments of NSW and Victoria.

For over 30 years research programs have tracked the population dynamics of the species and the information has been used to inform conservation management decisions. In Kosciuszko National Park this research program has been managed by Dr Linda Broome with the support of university researchers, students and volunteers. Some of Dr Broome's volunteers have worked on the annual surveys for over 20 years.

'The mountain pygmy-possum: on the edge' project has been developed to provide quality educational material for teachers and secondary school students to assist them to better understand threatened species conservation and the role the community can play as volunteers working on research projects and as supporters of the work.

STUDENT TASKS

'The mountain pygmy-possum: on the edge' project presents two tasks for students.

1. Demonstrates how a Geographic Information System (GIS) can be used for threatened species conservation work.
2. Explains how a Capture-Mark-Recapture (CMR) survey is used to monitor populations and species to inform management responses.

The tasks apply the scientific process and the use of GIS to answer conservation management questions related to the endangered mountain pygmy-possum.

Instructions and worksheets to complete the tasks are included in this booklet along with follow-up questions. Task 1 uses a publicly accessible, online GIS.

Geographic Information Systems (GIS)

GIS are integrated digital tools used to explore spatial or geographical data. By translating numbers and data into visual layers we can more easily handle, process and analyse these data. These visual layers can be overlaid to see where a range of geographical features intersect.

Task 1 uses GIS and known information about mountain pygmy-possum habitat requirements to identify high-quality mountain pygmy-possum habitat in Kosciuszko National Park.

Capture-Mark-Recapture (CMR)

CMR is a survey system used to calculate population size.

Task 2 uses data collected during a capture-mark-recapture survey to calculate population size and evaluate population dynamics.

Top: Dr Linda Broome and a mountain pygmy-possum (Robert Thomas)
Bottom: Mountain pygmy-possum (Dan Nicholls)

BACKGROUND

IS KOSCIUSZKO'S CUTEST ANIMAL ABOUT TO DISAPPEAR?

Only high quality research and good management can save the mountain pygmy-possum. It is your task to identify suitable habitat sites where populations of possums may be living.

MOUNTAIN PYGMY-POSSUM HABITAT

Mountain pygmy-possums live in the cooler alpine and subalpine areas of NSW and Victoria. They may overheat, or even die, if exposed to temperatures above 28ºC for several days.

They are also vulnerable to the extremely cold, winter conditions found in alpine environments. To survive very low winter temperatures and cold winds, the possums remain in the small space, insulated by snow cover that exists between the ground and the snow, called the subnivean space. The temperature within the subnivean space ranges between -2º and +2ºC, whereas the winter temperatures above the snow can drop as low as -22ºC.

All known mountain pygmy-possum populations are found living amongst the cracks and crevices of the mountain boulder fields. Other living (biotic) and non-living (abiotic) factors make some boulder fields higher quality habitat than others for mountain pygmy-possum populations. These factors include:

- Aspect
- Water availability
- Available food, importantly mountain plum-pine seeds and bogong moths, and
- Boulder field structure – area and depth

MOUNTAIN PYGMY-POSSUM THREATS

The mountain pygmy-possum is endangered as its population size has decreased to very low levels. The total number of animals, across all habitats, is estimated to be less than 3000. These estimates come from Capture-Mark-Recapture programs (CMR) undertaken in NSW and Victoria.

The mountain pygmy-possum is endangered for a number of reasons:

- The populations are vulnerable to predation by foxes and cats and the effects on habitat from ski resorts.
- Individual populations are small and separated by inhospitable terrain. This means that if an individual population is disturbed by fire, habitat alteration, disease or predation it can't be readily replenished by individuals dispersing from neighbouring populations.
- Mountain pygmy-possum populations are vulnerable to environmental variation from climate change, including reduced snow cover and warmer temperatures.

Mountain pygmy-possum habitat, boulder fields and mountain plum pine (Mel Schroder)

GIS

HOW TO NAVIGATE THE GEOGRAPHIC INFORMATION SYSTEM (GIS)

The GIS Viewer for this task is located http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=MPP

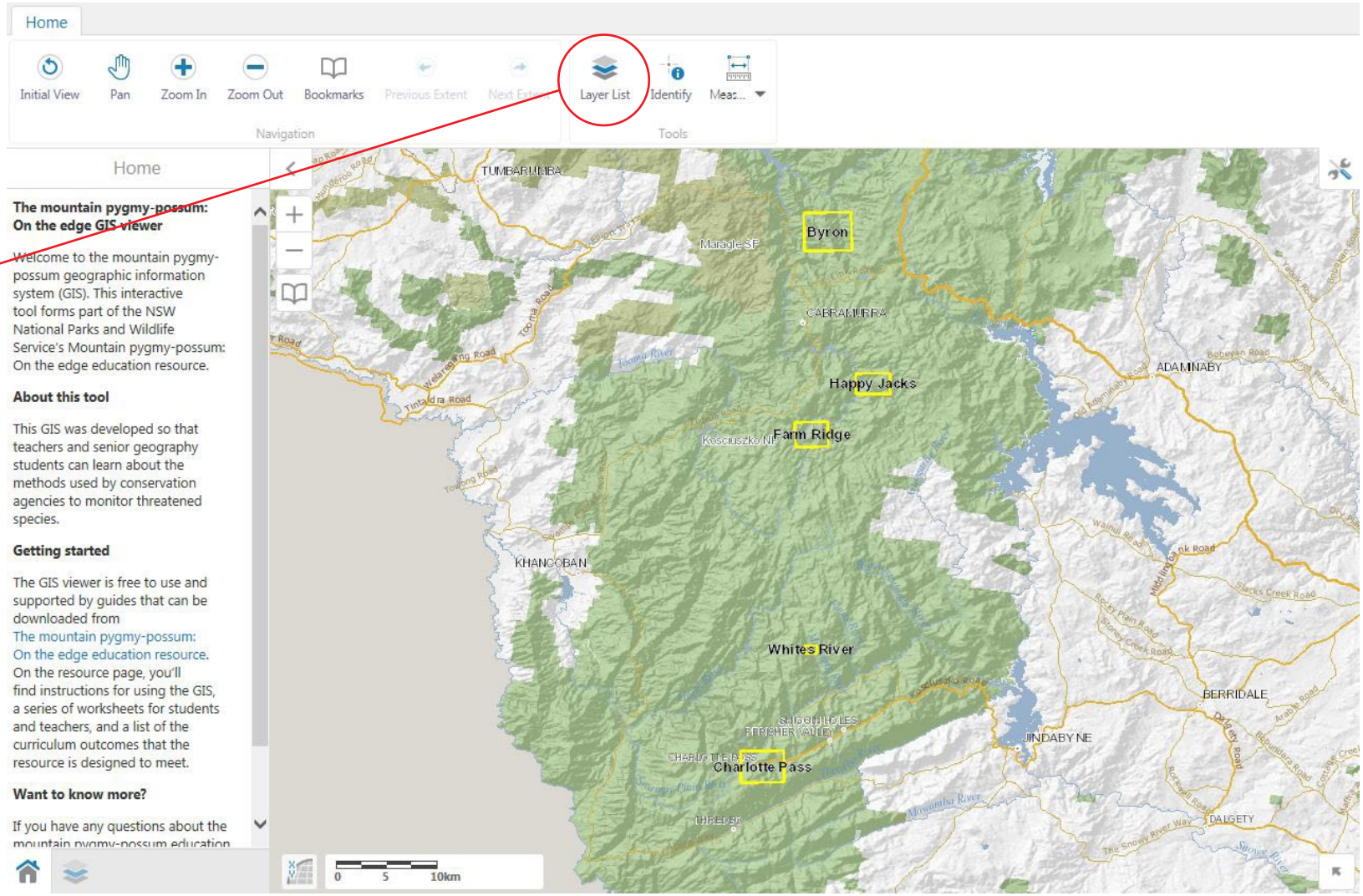
OPENING PAGE

When you click on the link above you arrive at the opening page.

The map you see on the GIS is oriented with North at the top.

Layer List

To start click this button to view the ‘Layers List’.



GIS

HOW TO NAVIGATE THE GEOGRAPHIC INFORMATION SYSTEM (GIS)

The GIS Viewer for this task is located http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=MPP

Initial View

This button returns you to the opening/initial view of the study area.

Bookmark

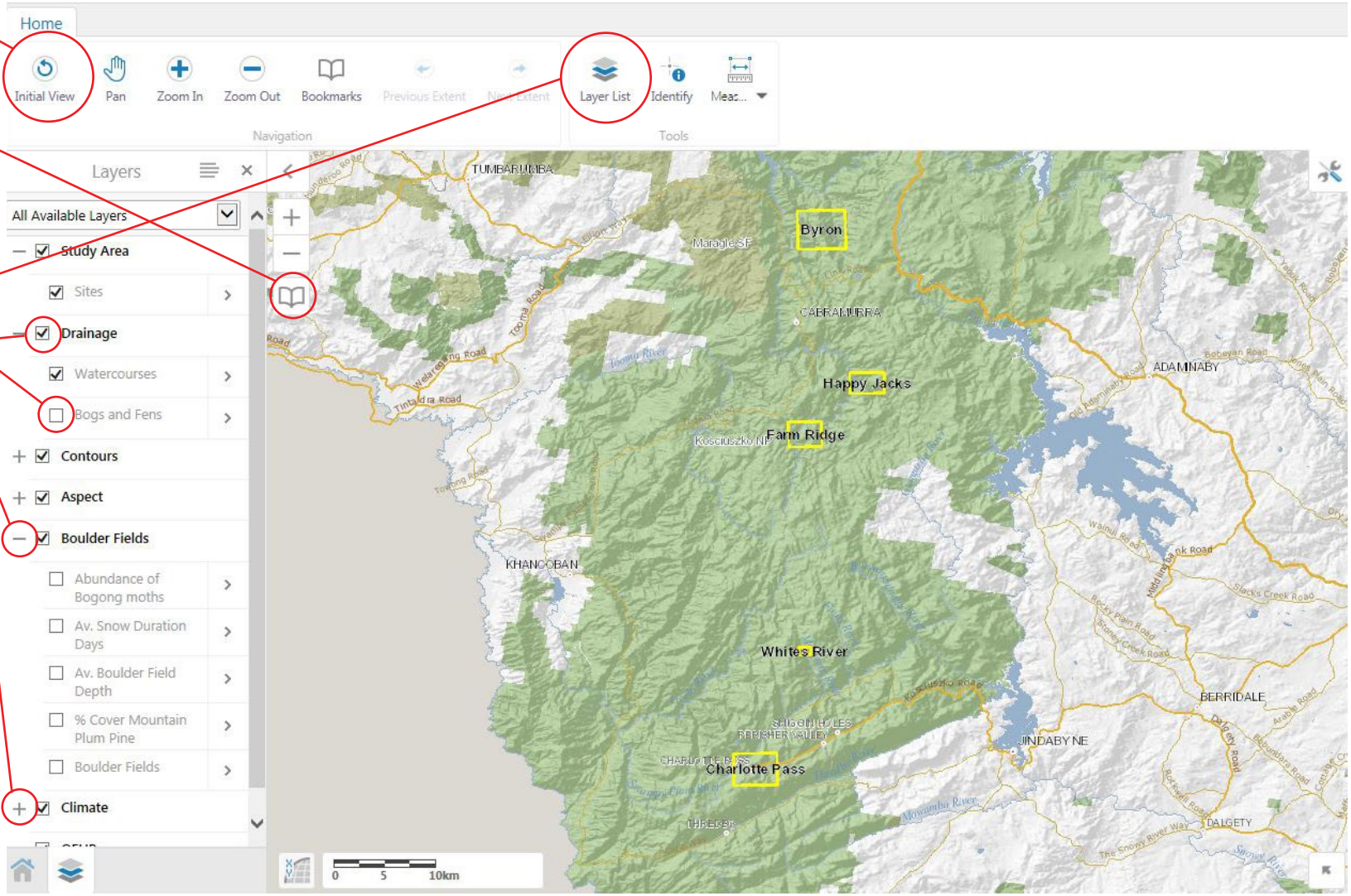
Pre-set areas of the map. Bookmarks allow you to switch between sections of the map.

Layer list

GIS data are displayed in layers. Layers are switched on and off using the Tick boxes in the Layer list.

Plus and Minus

These signs in the Layers list are used to open the GIS layers and may allow further detail of the layer to be explored.



GIS

HOW TO NAVIGATE THE GEOGRAPHIC INFORMATION SYSTEM (GIS)

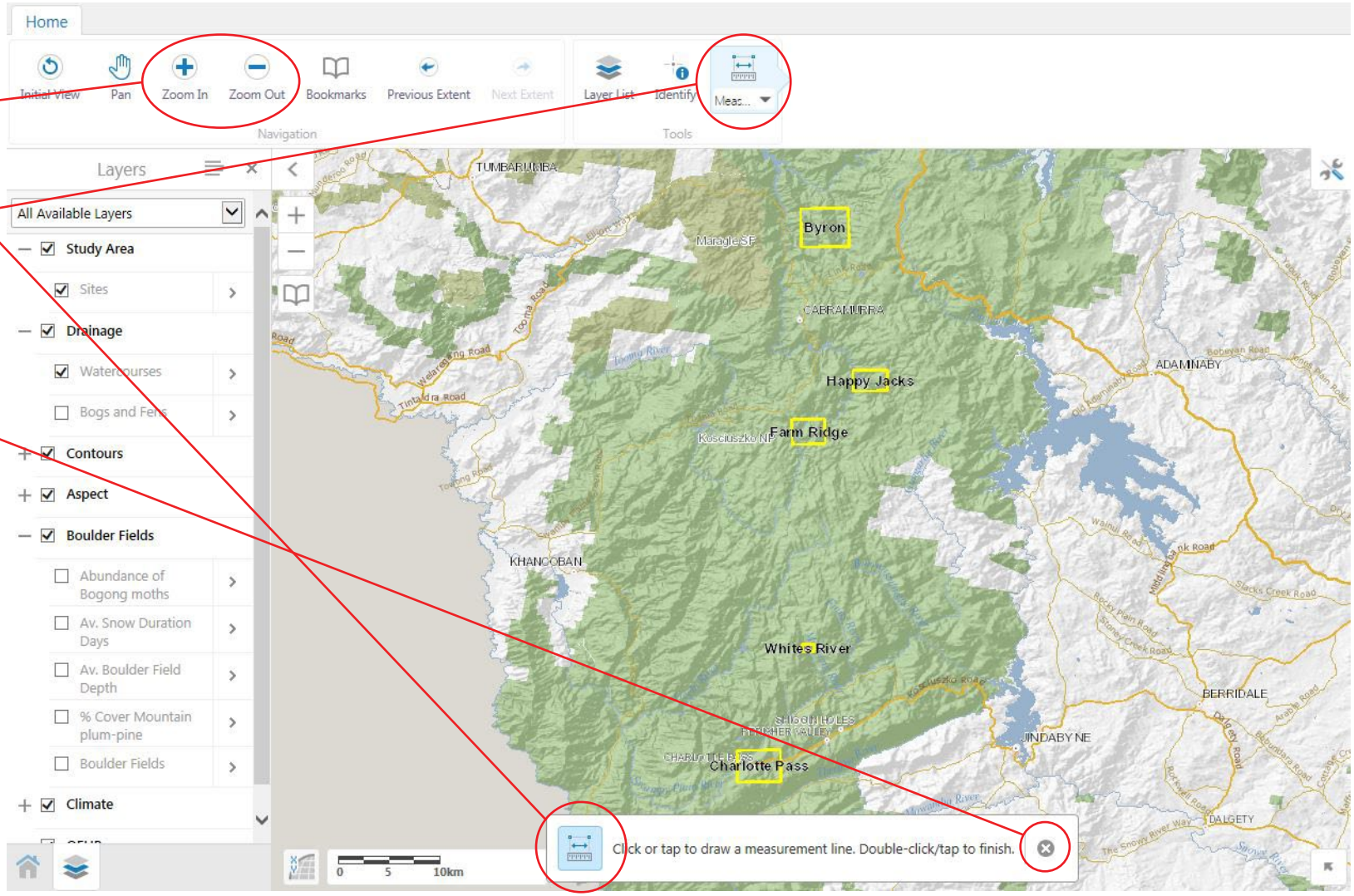
The GIS Viewer for this task is located http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=MPP

Zoom in / Zoom out

Measuring tool

Select the measuring tool and instructions on its use will appear at the bottom of the page.

Once finished, switch off the measuring tool here.



GIS

HOW TO NAVIGATE THE GEOGRAPHIC INFORMATION SYSTEM (GIS)

The GIS Viewer for this task is located http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=MPP

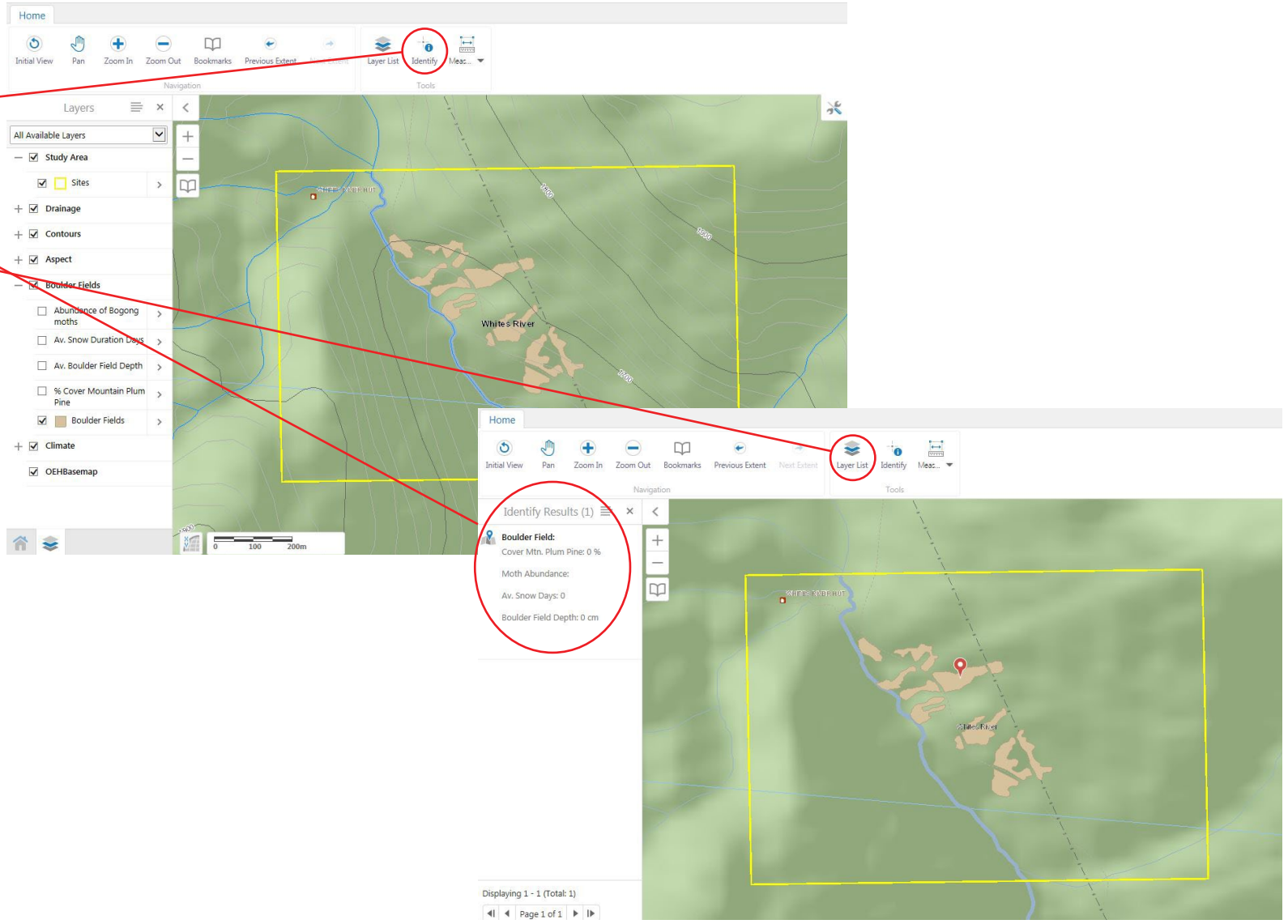
Identify tool

Select this tool and click on a feature to reveal more information about that feature.

The additional information appears here.

Layer List

Use this button to return to the Layer list.



TASK ONE

GIS TASK - PART ONE

The GIS Viewer for this task is located http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=MPP

INTRODUCTION

Five study areas in Kosciuszko National Park have been identified as possible mountain pygmy-possum habitat:

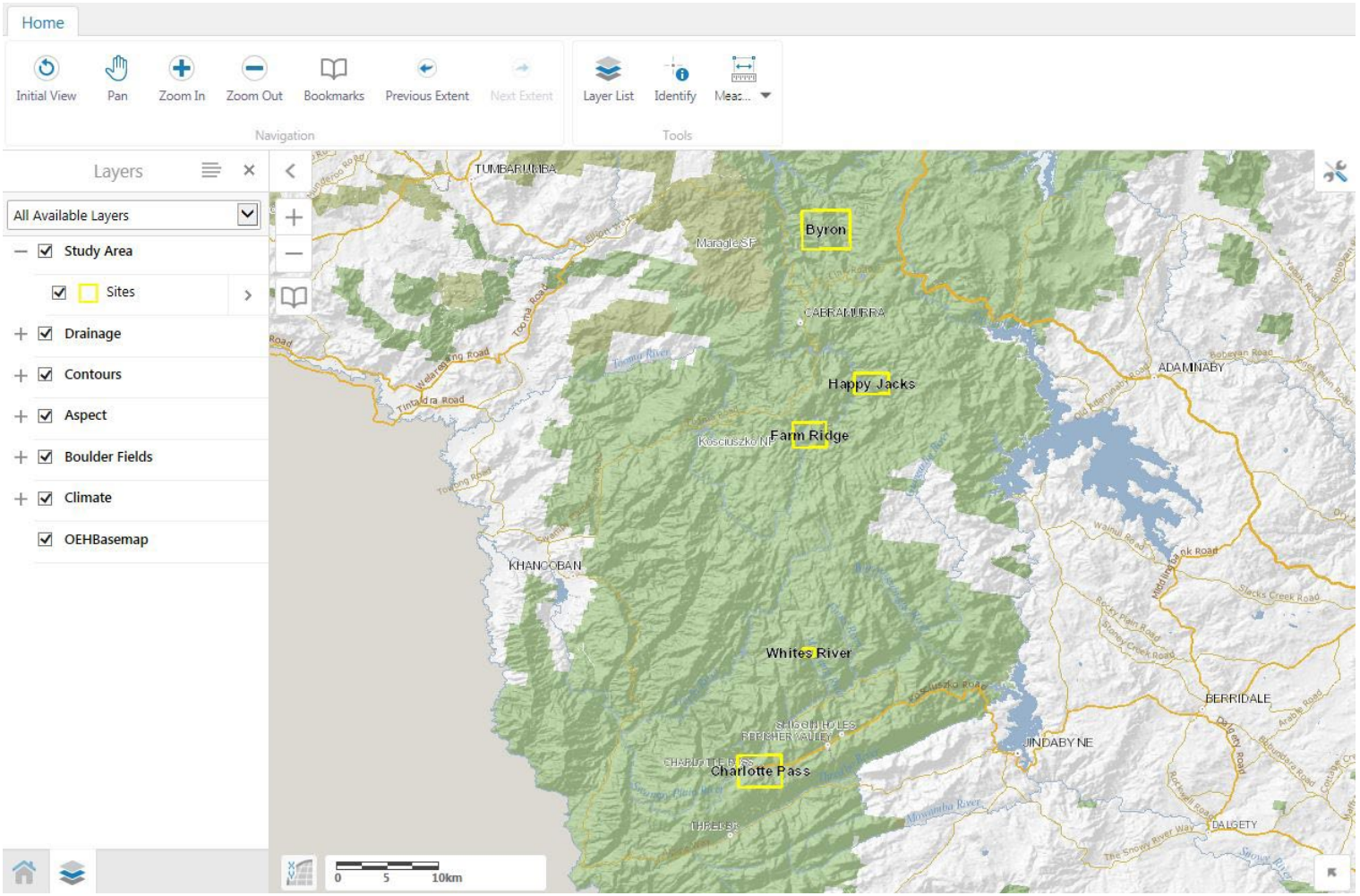
- Byron
- Happy Jacks
- Farm Ridge
- Whites River
- Charlotte Pass

You will be selecting the site that offers the best habitat conditions for the mountain pygmy-possum.

These five study areas have been identified as they occur within the altitude range where mountain pygmy-possums have previously been found. They also have areas of boulder fields (g), an essential habitat for the possums.

Your task is to investigate the altitude (g) and climate for each of the five sites.

Use the GIS task worksheet to record your data.



TASK ONE

GIS TASK - PART ONE

The GIS Viewer for this task is located http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=MPP

1.1 ALTITUDE

Temperature drops with altitude (approximately 6°C per 1000 m).

To find the altitude of each site:

Use the **Plus** sign to **Open up** the Contours layer details (seen opened in the lower map)

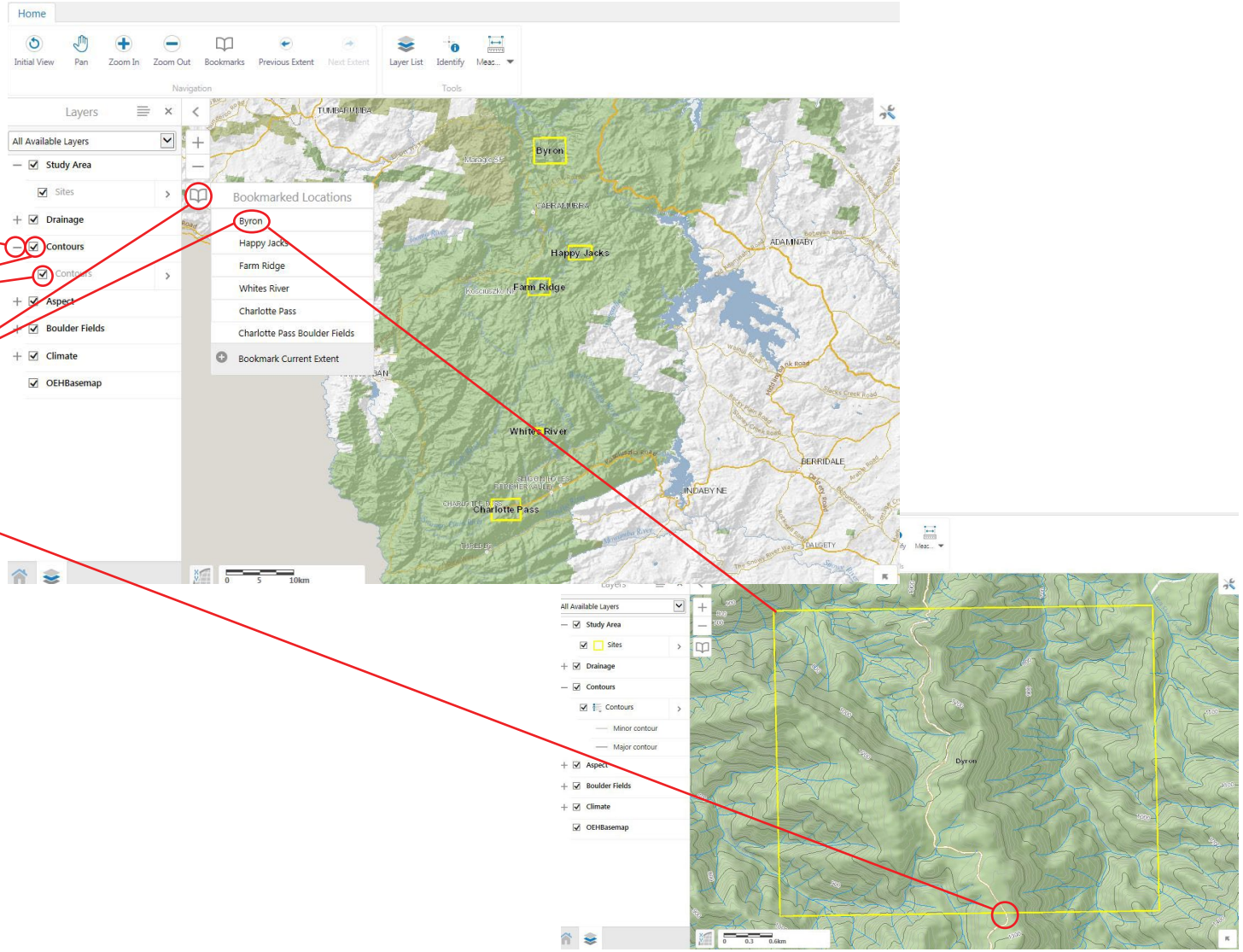
Check both Contours Tick boxes

Use the **Bookmarks** to switch between the five Study Area sites and record the highest altitude within the Yellow area outlined at each site.

Byron	1280 m
Happy Jacks	?
Farm Ridge	?
Whites River	?
Charlotte Pass	?

Review the altitude of the five bookmarked sites and rank the Study Area sites 1-5, with the highest altitude = 1 and the lowest altitude = 5

Record on the GIS Task Worksheet.



TASK ONE

GIS TASK - PART ONE

The GIS Viewer for this task is located http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=MPP

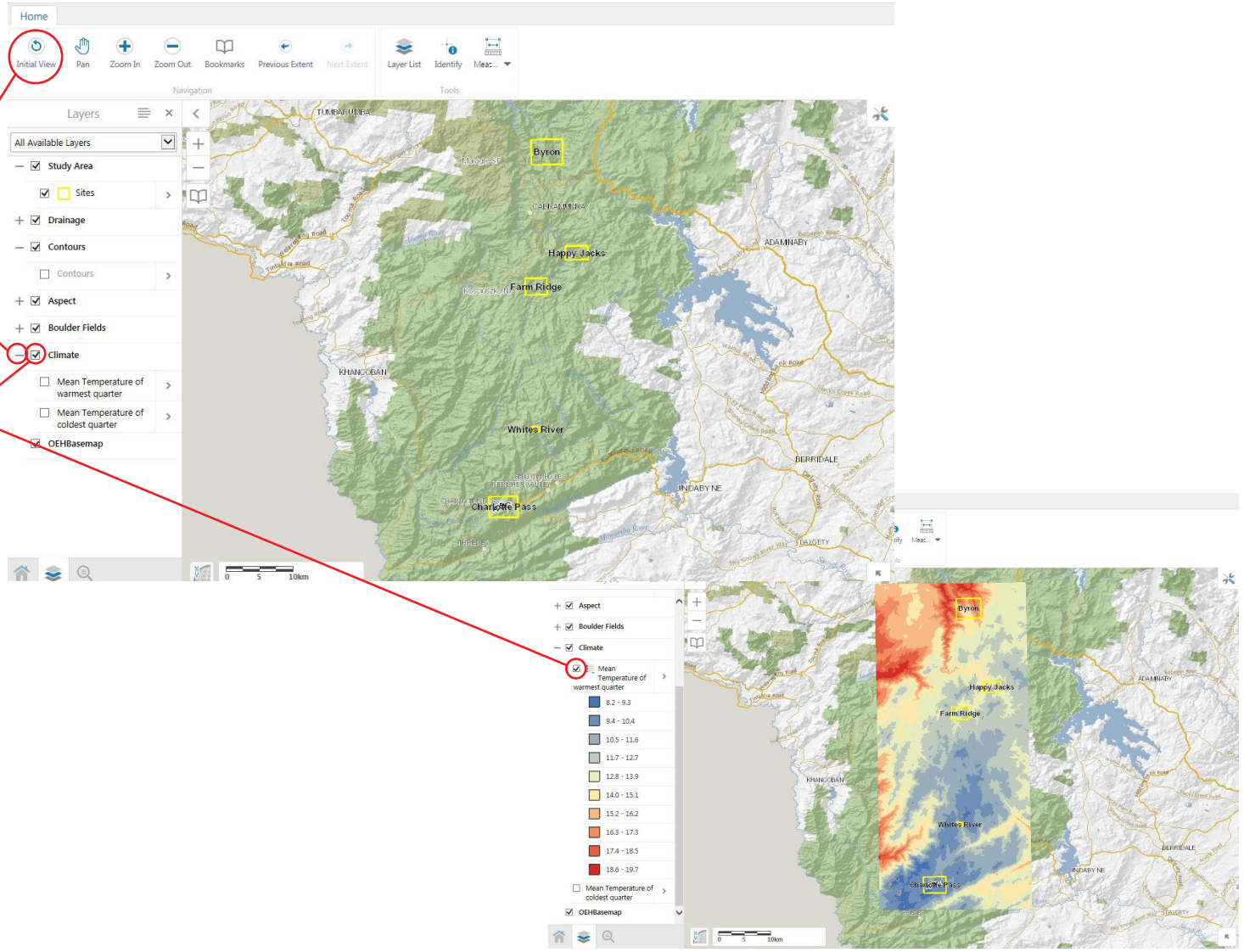
1.2 CLIMATE

To find the temperature information for each site:

Use button to return to the **Initial View** of the map.

Use the **Plus** sign to **Open** the Climate layer details.

Use the **Tick** box to **Switch on** both the Climate and Mean Temperature of warmest quarter.



TASK ONE

GIS TASK - PART ONE

The GIS Viewer for this task is located http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=MPP

1.2 - CLIMATE

Use the Bookmark to review and rank each of the five Study Areas.

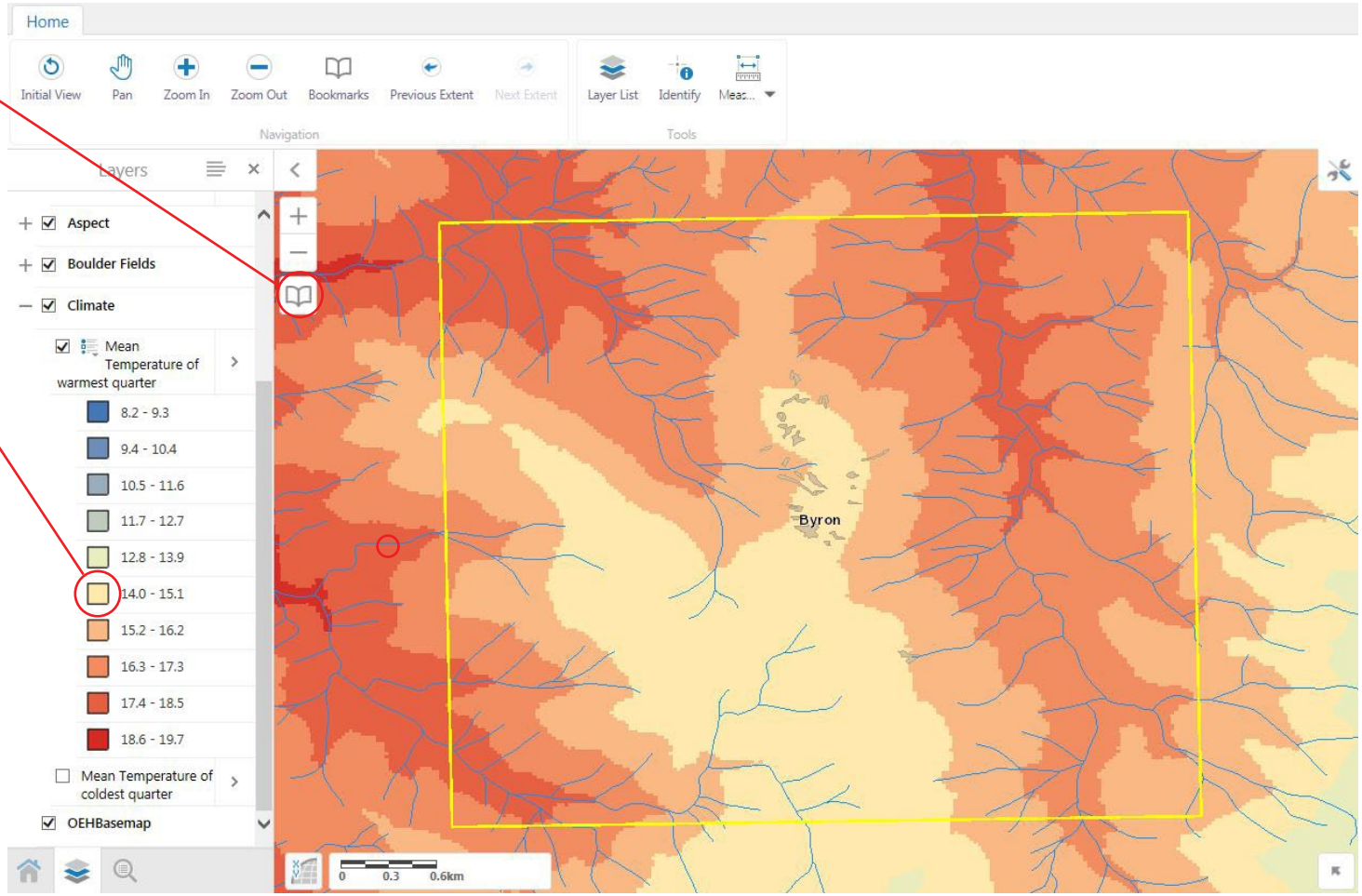
Identify and record the coldest temperature range that appears in each Study Area.

Byron	14.0–15.1
Charlotte Pass	?
Happy Jacks	?
Whites River	?
Farm Ridge	?

Rank 1 for coldest Study Area through to 5 for warmest.

Record these rankings on the GIS Worksheet.

Use the **Tick** box to **Switch off** the Countours, Climate and Temperature layers, **Minus** to close the Contours and Climate layer. Return to the Initial View.



1.3 - RANK SITES

Based on your examination of the altitude and temperature data, rank the five Study Area sites. The Study Area ranked 1 is the site most likely to provide the best conditions for mountain pygmy-possums.

TASK ONE

GIS TASK - PART TWO

The GIS Viewer for this task is located http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=MPP

2. CHARLOTTE PASS BOULDER FIELDS

Potential mountain pygmy-possum habitat is further restricted as their preferred habitat is within boulder fields.

Additionally, other living (biotic) and non-living (abiotic) factors make some boulder fields higher quality habitat than others for mountain pygmy-possum populations. These factors include:

- Aspect
- Water availability
- Available food, importantly mountain plum-pine seeds and bogong moths
- Boulder field structure – area and depth

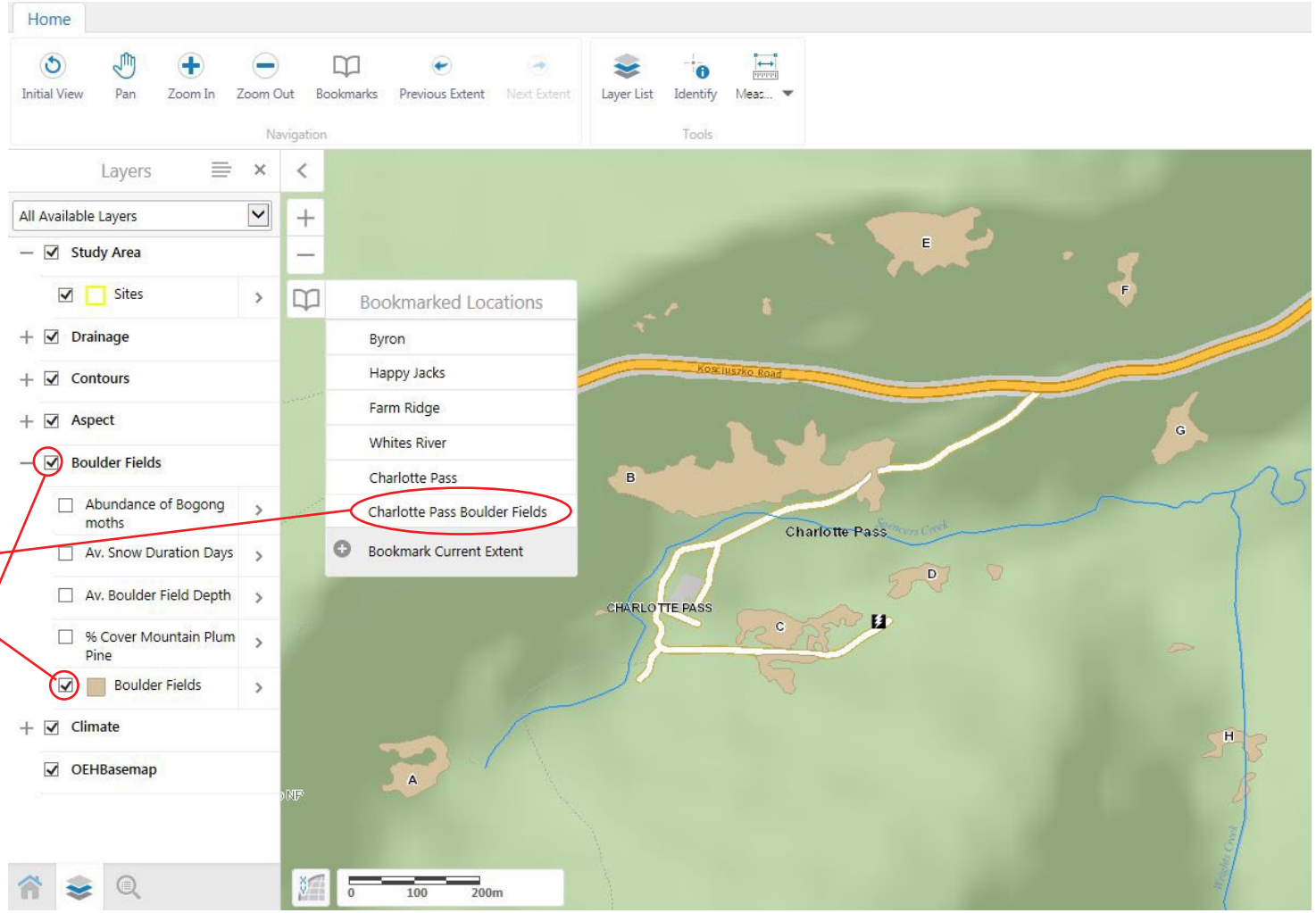
You will use these variables to identify the boulder field sites at Charlotte Pass that are more likely to support mountain pygmy-possums.

Use the **Bookmarks** to switch to the Charlotte Pass Boulder Fields view.

Use the **Plus** to open the Boulder Fields details and use the **Tick** box to **Switch on** both Boulder Fields boxes.

Review the Charlotte Pass Boulder Fields view.

You will see eight large boulder fields across the valley. These fields are identified with a letter A, B, C, D, E, F, G or H



TASK ONE

GIS TASK - PART TWO

The GIS Viewer for this task is located http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=MPP

2. CHARLOTTE PASS BOULDER FIELDS

Charlotte Pass_Site A (Dan Nicholls)

Charlotte Pass_Site B (Dan Nicholls)

Charlotte Pass_Site C (Dan Nicholls)

Charlotte Pass_Site D (Dan Nicholls)

TASK ONE

GIS TASK - PART TWO

The GIS Viewer for this task is located http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=MPP

2. CHARLOTTE PASS BOULDER FIELDS

Charlotte Pass_Site E.1 (Dan Nicholls)

Charlotte Pass_Site E.2 (Dan Nicholls)

Charlotte Pass_Site F (Dan Nicholls)

Charlotte Pass_Site G (Dan Nicholls)

TASK ONE

GIS TASK - PART TWO

The GIS Viewer for this task is located http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=MPP

2.1 ASPECT

Southerly aspects (g) are cooler in summer and shaded in winter. This allows insulating snow cover to last longer into spring. The snow cover helps protect the mountain pygmy-possum habitat from extremely cold winter air temperatures.

Easterly aspects are exposed to cool morning sunlight. Also, most weather fronts carrying snow approach the mountains from the west and south-west, resulting in snow accumulating on the eastern side of the range. This snow cover insulates the habitat from the extremely cold winter air temperatures.

Northerly aspects are warmer in summer and tend to lose snow cover earlier in spring. The rapid loss of snow cover after winter can expose the sites to very cold air temperatures in late winter and early spring.

Westerly aspects are exposed to warm afternoon sun causing the snow cover to melt earlier in spring, possibly exposing the habitat to cold fronts moving across the range. The hot afternoon sun may make some west-facing sites too warm in mid-summer.

The Main Range, Koscisuzko National Park. (Dan Nicholls)

TASK ONE

GIS TASK - PART TWO

The GIS Viewer for this task is located http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=MPP

2.1 - ASPECT

Use the GIS task worksheet to record your investigation of the following factors.

Use the **Plus** signs to **Open** the Contours and Aspect layer details.

Use the **Tick** box to **Switch on** the Contours and Aspect layers.

Ensure both Contour and Aspect tick boxes are ticked.

Identify the aspect for each of the identified boulder fields.

Score 3: for North-facing fields (i.e. field D)

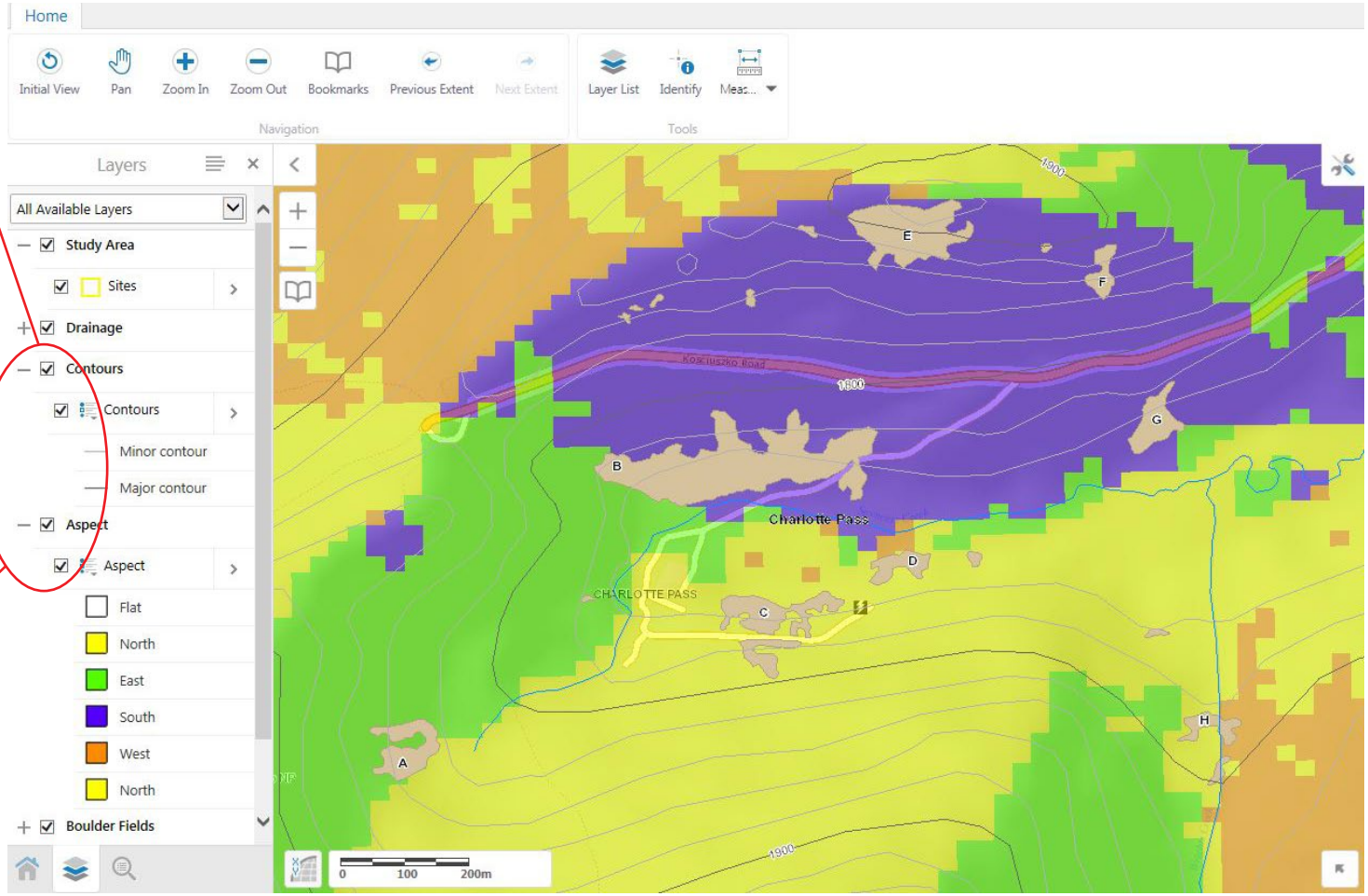
Score 2: for East-facing fields

Score 1: for South-facing fields

Score 3: for West-facing fields

Use the **Tick** box to **Switch off** the **Aspect** and **Contours** layers.

Use **Minus** to close the layer details.



TASK ONE

GIS TASK - PART TWO

The GIS Viewer for this task is located http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=MPP

2.2 - WATER AVAILABILITY

As mountain pygmy-possums move about below the boulder fields and low-growing shrubs and heath, water availability ⓖ within these fields is important.

Use **Plus** to **Open** the Drainage layer

Use the **Tick** boxes to **Switch on** Watercourses and Bogs and Fens ⓖ layers.

Review each of the eight Boulder Fields (Identified with A,B,C…).

ⓖ Score 1: next to any field that...

- has a river flowing through it and/or
- is immediately adjacent to an area of Alpine Bog or Fen ⓖ.

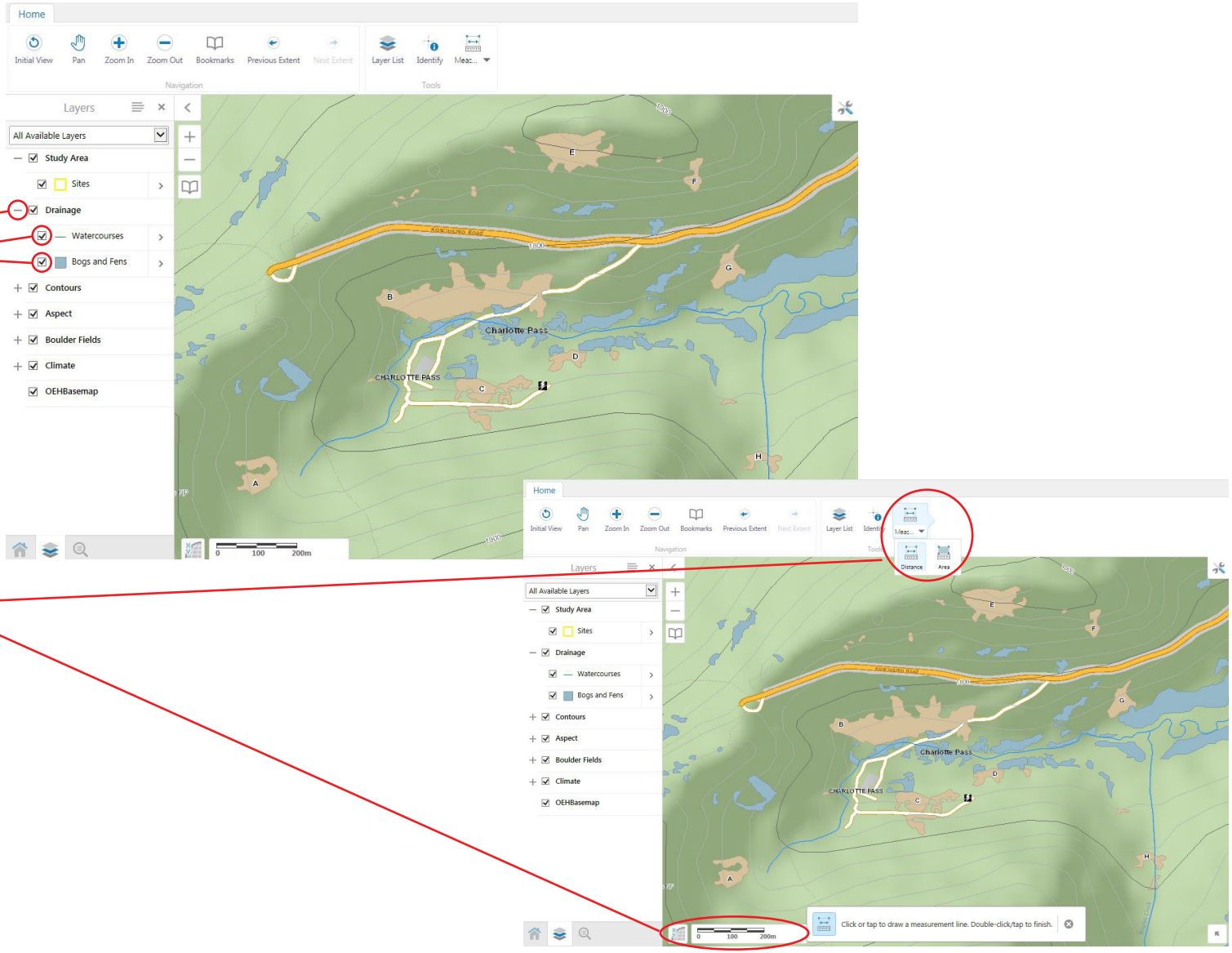
Score 2: next to any field that has water within 75 m of the boundary.

Score 3: next to any field that has water further than 75m from the boundary.

Use the Measuring Tool or the scale to determine these distances. *(Windows - Use F5 to refresh the browser and remove measurements; Mac - Use Command - R)*

Navigate back to Charlotte Pass Boulder Fields and **Switch on** Boulder Fields layer to continue

Use the **Tick** Boxes to **Switch off** Watercourses and Bogs and Fens layers and **Minus** to close the layer details.



TASK ONE

GIS TASK - PART TWO

The GIS Viewer for this task is located http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=MPP

2.3 - MOUNTAIN PLUM-PINE

Outside the breeding seasons more than half of the mountain pygmy-possum's diet is made up of fruits and seeds. Mountain plum-pine seeds are a food source for mountain pygmy-possums. The higher the % Cover of mountain plum-pine, the higher quality habitat a boulder field may be.

Use **Plus** to **Open** the Boulder Fields layer details.

Switch on % Cover Mountain plum-pine and review % Cover at each of the eight identified habitat fields (A,B,C…).

The % Cover Mountain plum-pine layer displays data divided into 6 ranges from 29.9-25% Cover to 4.9 - 0% Cover.

Rank all the fields using the information below.

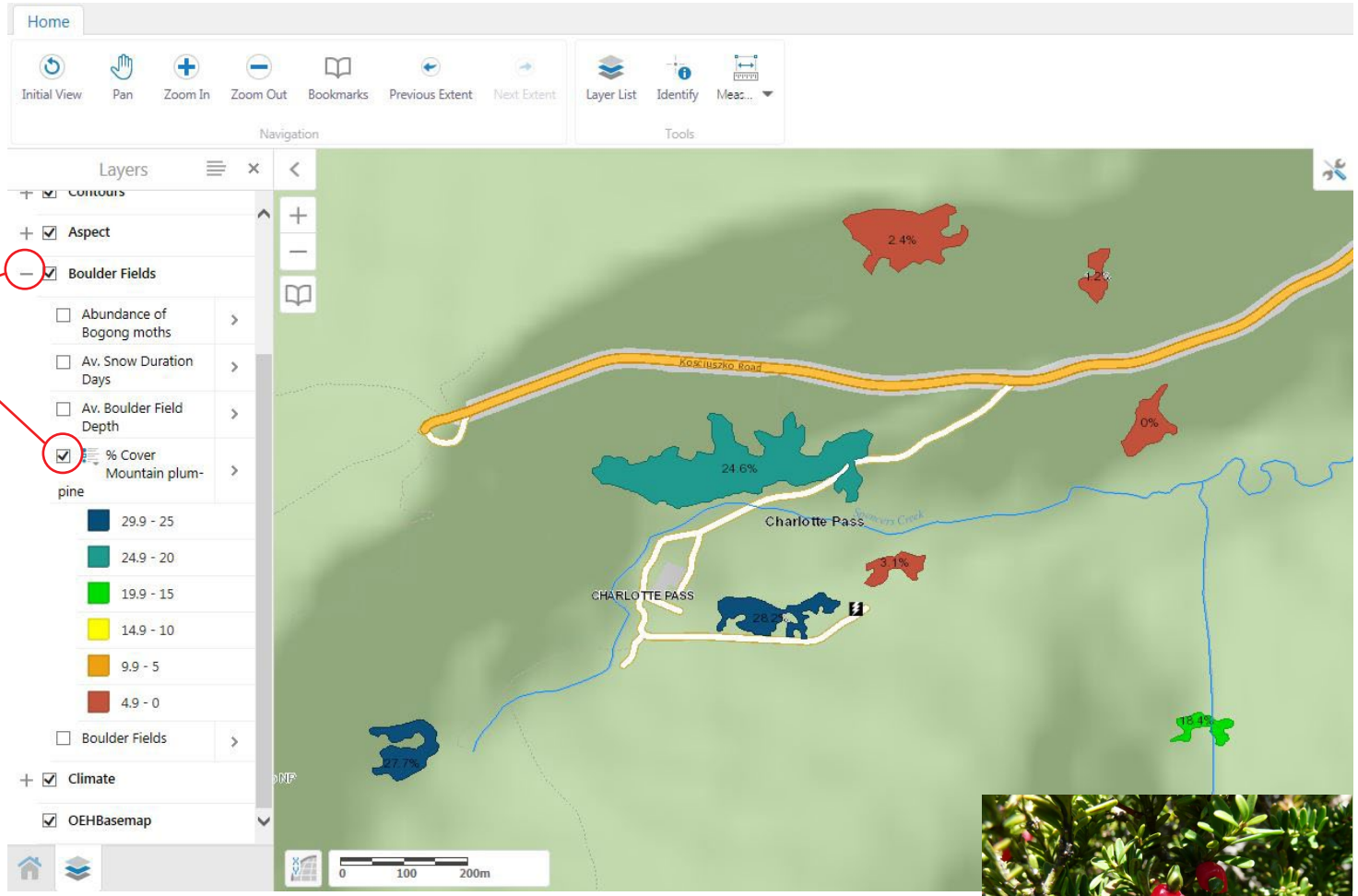
Rank 1: 29.9-25%, Rank 2: 24.9-20%,

Rank 3: 19.9-15%, Rank 4: 14.9-10%,

Rank 5: 9.9-5%, Rank 6: 4.9-0%

Note: some ranges/ranks may not be represented.

Switch off % Cover Mountain plum-pine layer.



Mountain plum-pine seeds, fruits and leaves (Linda Broome)

TASK ONE

GIS TASK - PART TWO

The GIS Viewer for this task is located http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=MPP

2.4 - BOGONG MOTH ABUNDANCE

During the breeding season, bogong moths make up about 25% of the mountain pygmy-possum's diet. Greater abundance of these insects within a boulder field may influence population numbers.

Switch on Abundance of Bogong moths and review abundance at each of the 8 identified habitat fields (A,B,C…).

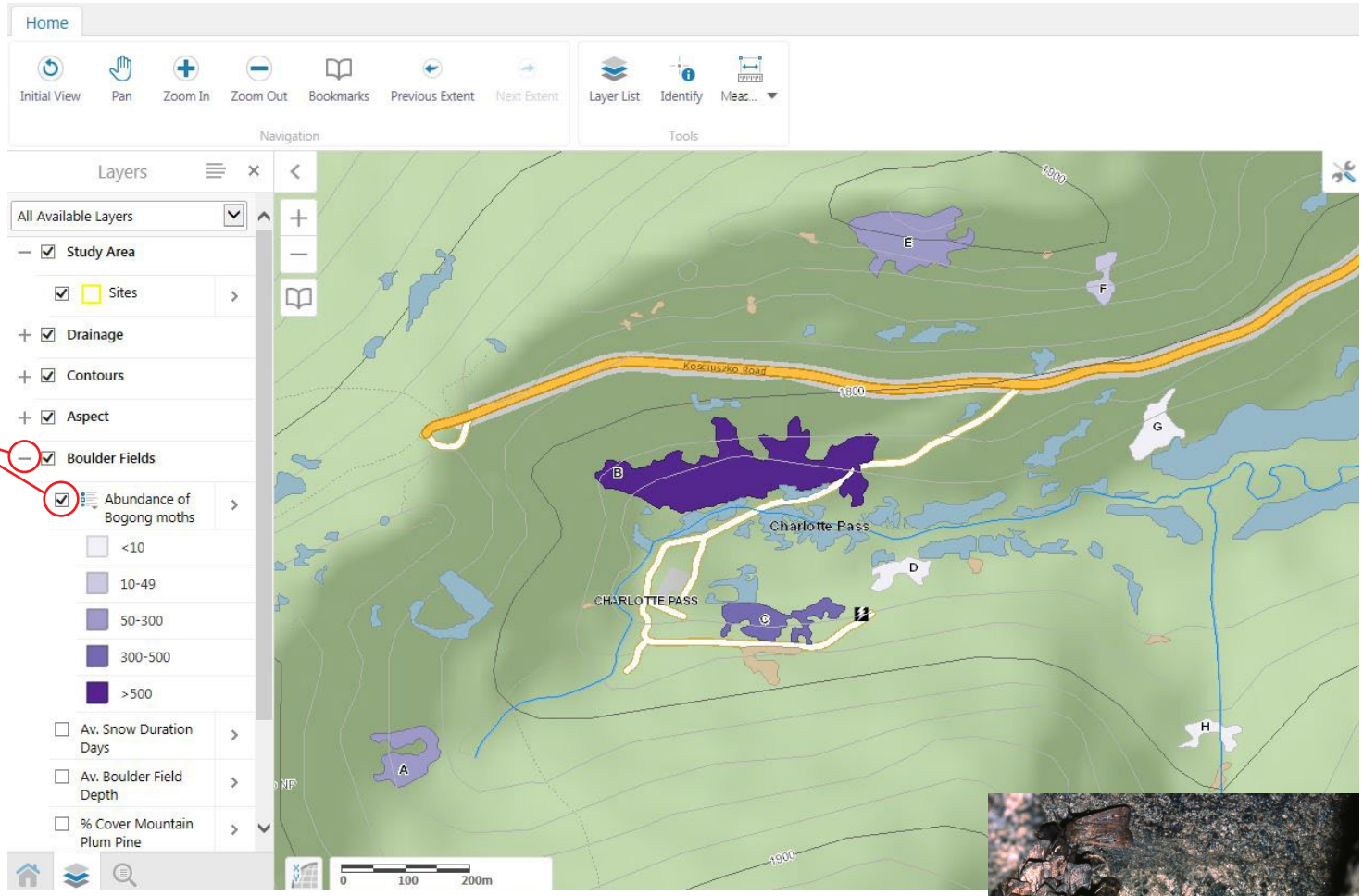
These data represent the average number of Bogong moths caught (per night) in light traps set at each site. The layer displays data divided into five ranges from <10 to >500.

Based on the information above, determine for yourself how to rank these data.

IMPORTANT: the range that offers the best conditions should be ranked 1 and the range that offers the poorest conditions ranked 5.

Note: some ranges may not be represented.

Switch off the Abundance of Bogong Moths layer.



Bogong Moths (Linda Broome)

TASK ONE

GIS TASK - PART TWO

The GIS Viewer for this task is located http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=MPP

2.5 - BOULDER FIELD DEPTH

Boulder fields are essential habitat for mountain pygmy-possum populations. However, boulder fields can vary in area and depth. Deeper boulder fields provide greater protection from high temperatures in summer and cold temperatures in winter. They may also provide greater protection from introduced predators like foxes and cats.

Switch on the Av. Boulder Field Depth layer.

The Av. Boulder Field Depth layer data are divided into five ranges from 40-59cm to 120-139cm.

Understanding that a deeper boulder field may have a positive influence on mountain pygmy-possum population numbers, determine for yourself how to rank these data.

IMPORTANT: the range that offers the best conditions should be ranked 1 and the range that offers the poorest conditions ranked 5.

Note: some ranges may not be represented.

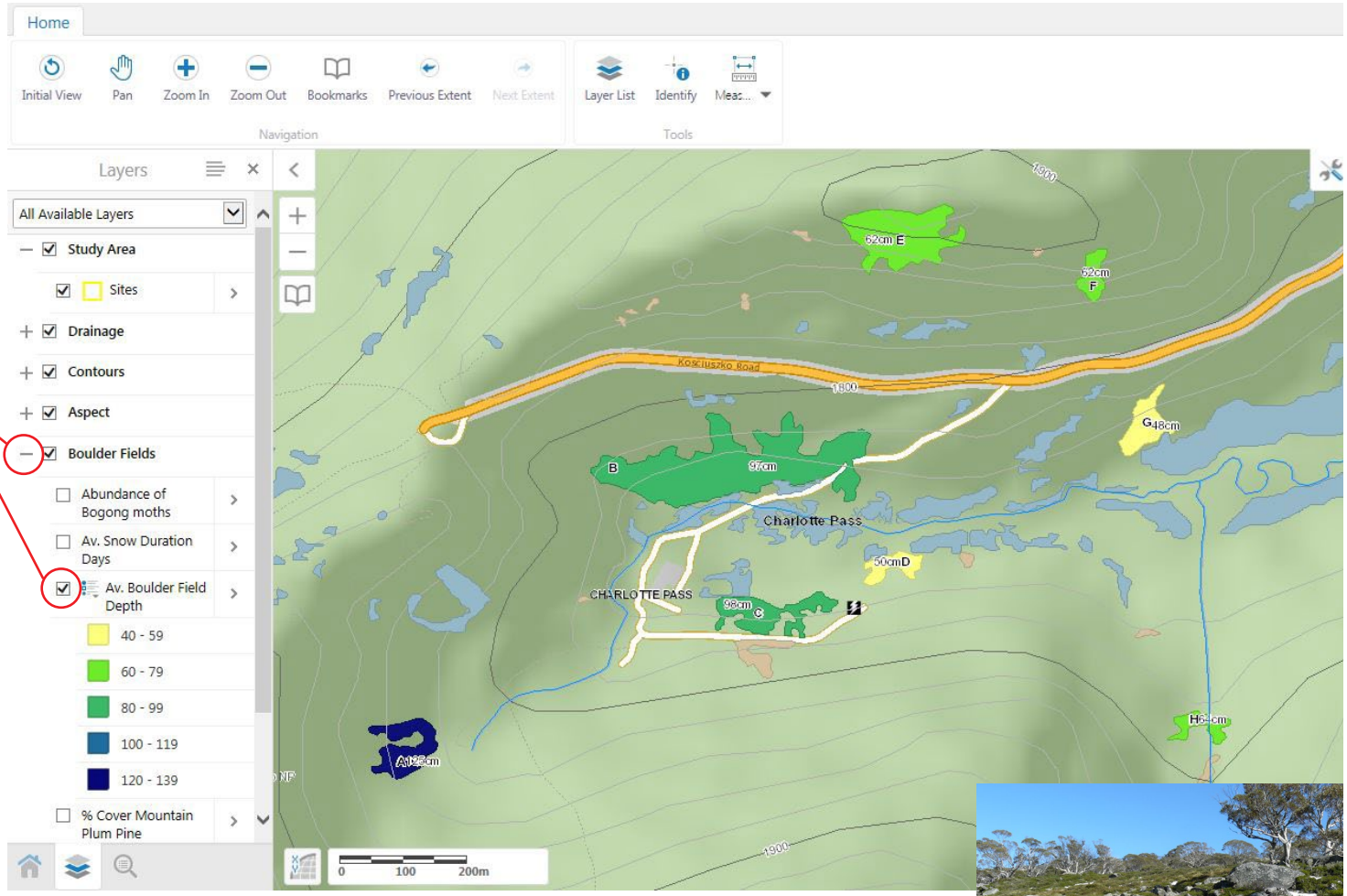


Image: Boulder fields, Kosciuszko (Mel Schroeder)

TASK ONE

GIS TASK - PART TWO

The GIS Viewer for this task is located http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=MPP

2.6 - SNOW DURATION DAYS

Surviving winter is complicated by a lack of food. In addition, the colder the air temperature, the more energy a mountain pygmy-possum uses. To counteract this, mountain pygmy-possums sleep or go into torpor (g),sleeping for up to 20 days in a row. When asleep, the body cools and respiration drops, conserving energy. In winter, an insulating snow cover helps prevent extremely cold air from sinking into boulder field habitats. The longer this insulating snow cover lasts into spring, the more protection a sleeping mountain pygmy-possum has from cold temperatures.

Switch on the Av. Snow Duration Days layer.

The Av Snow Duration Days data are displayed in seven ranges from 80-84 days to 110-114 days.

Understanding that a longer period of snow cover will have a positive influence on mountain pygmy-possum populations, determine for yourself how to rank these data.

IMPORTANT: the range that offers the best conditions should be ranked 1 and the range that offers the poorest conditions ranked 7.

Note: some ranges may not be represented.

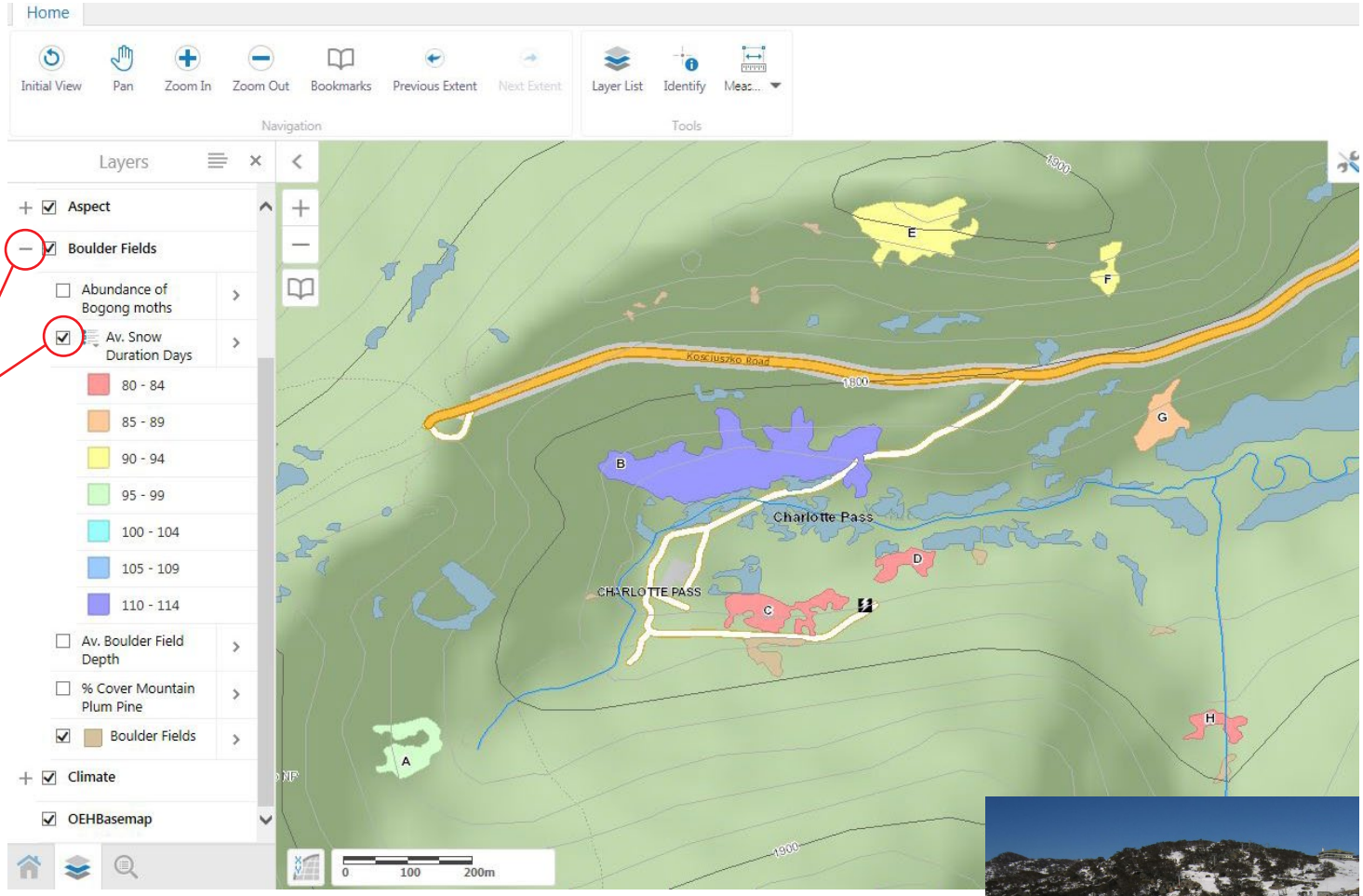


Image: Winter, Blue Cow boulderfields (Linda Broome)

TASK ONE

GIS TASK - WORKSHEET

The GIS Viewer for this task is located http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=MPP

PART ONE

study area	STEP ONE		STEP TWO		STEP THREE
	altitude	rank	temperature	rank	OVERALL RANK
Byron	1280 m		14.0-15.1°C		
Happy Jacks					
Farm Ridge					
Whites River					
Charlotte Pass					

Rank 1-5, the highest/coldest site = 1 and the lowest/warmest site = 5

Based on your overall ranking, the study area site with the most suitable conditions is: _____

PART TWO

boulder field	aspect	water availability	mountain plum-pine	abundance bogong moth	boulder field depth	snow cover days	SUM RESULTS
A							
B							
C							
D							
E							
F							
G							
H							

Based on the factors investigated here, the field with the lowest total sum should offer the most suitable conditions for the species.

Priority sites to survey – Result: _____

TASK ONE

FOLLOW-UP QUESTIONS

1. List the biophysical (biotic and abiotic) interactions that influence or identify suitable mountain pygmy-possum habitat.

Biophysical interaction	Sphere
e.g. Bogong moths – important source of food in the breeding season	Biosphere
e.g. Snow cover – helps prevent extremely cold winter temperatures from sinking into mountain pygmy-possum habitat	Cryosphere and Hydrosphere

2. Mountain pygmy-possum capture-mark-recapture population surveys run at Charlotte Pass reveal that boulder fields A, B & C are the most active habitats, with a recent survey returning a total abundance of A – 5; B – 45; C – 8. This confirms site B, the largest boulder field as the most active in the Charlotte Pass area.

   However, considering population density (animals per hectare), boulder field A, though a smaller site, supports more animals per hectare than boulder field B and more than twice the number of animals per hectare than boulder field C.

   A – 21.28 animals per hectare

   B – 20.10 animals per hectare

   C – 10.13 animals per hectare

   From your understanding of habitat requirements and preferences of the mountain pygmy-possum can you identify any factors that could explain this observation?

TASK ONE

FOLLOW-UP QUESTIONS

3. The mountain pygmy-possum is listed as endangered under the Australian Environmental Protection and Biodiversity Conservation Act and the NSW Threatened Species Conservation Act. There are a variety of threats that are both natural and cultural and some are more significant in the short term, up to 5 years. Others are of more significance in the long term, 20 years and more. LISTING Use this page to review the threats to the mountain pygmy-possum and, using information from your Tasks, answer the following:

   Select two threats to the MPP identified in the National Recovery Plan (Page 13) and describe the nature of the threatening processes and any human activities involved.

   Suggest ways these changes or disturbances could be reduced or nullified.

4. Research indicates that 40% of mountain pygmy-possum habitat is located in recognised downhill ski resort areas. List some strategies that resort operators could undertake to promote the sustainability of the mountain pygmy-possum habitat.

5. Individuals can be part of the solution to help reduce the impact on threatened species. Suggest ways that individual visitors to the Kosciuszko National Park can help the mountain pygmy-possum survive. Consider actions of visitors in both winter and summer.

TASK TWO

CAPTURE-MARK-RECAPTURE

MOUNTAIN PYGMY-POSSUM POPULATION MANAGEMENT

A population is a group of individuals from the same species that live within a defined area and compete to use the same resources (food, shelter and breeding partners).

It is important to know how many individuals exist within a population and how that number changes over time. When the population size is known, it is then possible to track increases and decreases in the population. These changes may be in response to cultural (man-made) or natural disturbances such as habitat clearing, fire and storms. Changes may also occur with management actions such as feral predator control program.

Natural resource managers working on threatened species conservation can use capture-mark-recapture programs to monitor populations and determine if numbers are increasing or in decline.

A capture-mark-recapture program involves trapping and capturing individuals from a population and tagging them in a way that doesn't affect their chance of survival. The tag can be an ear tag, a collar or, in the case of the mountain pygmy-possum, an electronic tag which is injected under the skin just like those used for microchipping pets. After the animal is tagged, it is released. At the same time the following year, the habitat is trapped again. The proportion of the animals caught the second time that are already tagged represents the proportion of the total population that is tagged. If one-third of the animals in the second capture are tagged then approximately one-third of the total population was tagged in the first capture. This, then, enables the researcher to calculate an approximate population size.

Top: Checking an 'Elliot trap' for a mountain pygmy-possum (Marnie Stewart)
Middle: Finding a mountain pygmy-possum in an Elliot trap (Rebecca Gibson)
Bottom: Researchers recording survey results (Thomas Polden)

TASK TWO

CAPTURE-MARK-RECAPTURE - PART ONE

REQUIRED

A number of mountain pygmy-possum cards (see following page for printable MPP cards).

The task requires the users to mark the cards.

The cards can be cut up and used once or cut up and laminated for repeated use.

Ten sheets will provide a serviceable number of cards for the task.

2.1 CAPTURE-MARK-RECAPTURE

Select a random number of MPP cards for your experiment (50 plus).

Trap this population by picking up 20 cards (CT1).

Mark these 'animals'. Use a non-permanent marker to mark the back of each of the 'trapped' animals.

Release these animals by shuffling them back with the rest of the MPP cards.

Trap this population a second time without looking; a blindfolded person would be best. Collect another 20 cards (C2).

Count the number of marked 'animals' caught in the second 'trapping' event. In the example below seven cards (T2).

2.2 ANALYSE YOUR DATA

$$P = \frac{CT1 \times C2}{T2}$$

P	= Population size
CT1	= Caught & tagged Trap One
C2	= Caught Trap Two
T2	= Tagged in Trap One and caught in Trap Two

Example

Trapping session 1: Caught, tagged & released 20 mountain pygmy-possums (MPP).

Trapping session 2: Caught 20 MPP, 7 tagged in Trap One

Example calculation

$$P = \frac{20 \times 20}{7} = \frac{400}{7} = 57$$

The example population above has 57 individuals.

TASK TWO

CAPTURE-MARK-RECAPTURE

Repeat the test several times using a random number of mountain pygmy-possum cards. Vary the number of animals caught in the:

- 1st trapping session
- 2nd trapping session

Does this impact the accuracy of the population estimates?

Record your data.

$$P = \frac{CT1 \times C2}{T2}$$

CMR 1 - 20 trapped each time P = ____ x ____ = ____ = ☐ Result

CMR 2 - change trap 1 number, 20 in trap 2 P = ____ x ____ = ____ = ☐ Result

CMR 3 - 20 in trap 1, change trap 2 number P = ____ x ____ = ____ = ☐ Result

CAPTURE-MARK-RECAPTURE - PART TWO

2.3 MPP POPULATION ESTIMATE

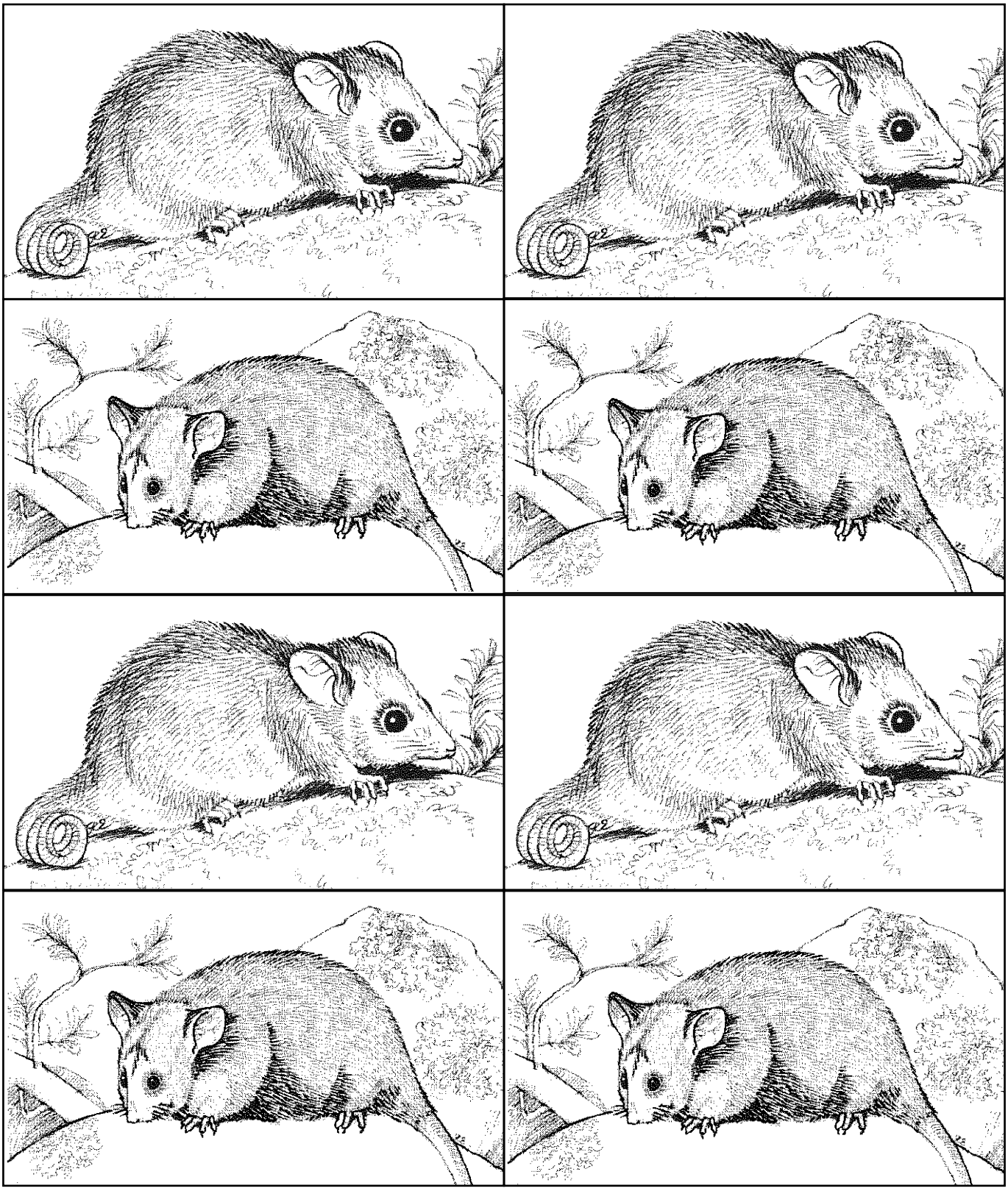
The following are real data derived from a Charlotte Pass mountain pygmy-possum CMR survey

Caught Trap One	*Caught Trap Two*	*Tagged in Trap One and caught in Trap Two*
CT1 - 22	C2 - 16	T2 - 6

P = ____ x ____ = ____ = ☐ Result

TASK TWO

CAPTURE-MARK-RECAPTURE - MPP CARDS



Images: ©OEH

TASK TWO

FOLLOW-UP QUESTIONS

1. Given that you know how many animals there are in the population, did this technique give you a close estimate of the total population size?

2. How does changing the number of animals caught in the first trapping event (and tagged) affect the population size estimate?

3. How does changing the number of animals caught in the second trapping event affect the population size estimate?

TASK TWO

FOLLOW-UP QUESTIONS

For the Mountain pygmy-possum capture-mark-recapture research conducted in Kosciuszko National Park to be successful and valid, many factors are considered. As well as ensuring the tags are permanent and will not affect the likelihood of survival or recapture, the confounding effects likely to exist in a wild population are births and immigration, which will add non-tagged individuals to your population between captures. These will increase the actual population size and decrease the proportion of tagged animals; meaning you would underestimate the population size. Deaths and emigration will have the opposite effect.

4. Are there any steps or elements of the experiment, as you conducted it, which could be confounding the results (causing confusion)?

THREATENED SPECIES IN NSW

Thirty years of mountain pygmy-possum research conducted in Kosciuszko National Park has provided us with an accurate understanding of the species' population dynamics and decline in NSW.

Across NSW species, populations and ecological communities are surveyed and monitored by researchers from government departments, universities, community organisations and by private citizens. These researchers collect information about the population numbers, whether they are declining and the type of threats that are impacting on the species. The NSW Scientific Committee is responsible for reviewing all the available scientific information and determines whether to list a species as threatened.

To make this decision the committee expects researchers to provide information on:

- the life history of the species, where it lives, what it eats, how and when it breeds
- the population dynamics of the species, the habitat requirements, the carrying capacity of that habitat and the ability of animals to move into (immigrate) and move away (emigrate) from the habitat, also how population numbers may decline and recover in response to natural disturbances in the environment and
- the impacts and possible impacts of introduced disturbances or threats on each population's viability

Based on these considerations and evidence of a sustained decrease in population numbers, the Scientific Committee may decide to list the species, population or ecological community as threatened. Listing invokes greater legislative protection of the species and its critical habitat and requires action be taken to prevent the extinction of the species. Conversely, the committee can also decide to de-list the species if the information provided shows the species is now stable and secure in the wild.

In 2015, 974 species were listed as threatened in NSW under the Threatened Species Conservation Act 1995. Of these, 72 species were presumed extinct g, 75 species were critically endangered g, 428 species were endangered g and 399 species were considered vulnerable g. Of the listed species, 657 species were plants, 317 species were animals.

You can find out more about individual threatened species, populations and ecological communities in NSW and the work going into securing them in the wild on the Office of Environment and Heritage website, Threatened Species section and Saving Our Species program.

Other threatened species found in Kosciuszko National Park.
Top: Mauve burr-daisy *Calotis glandulosa* (Keith McDougall)
Middle: Southern corroboree frog *Pseudophryne corroboree* (Dave Hunter)
Bottom: Flame robin *Petroica phoenicea* (Michael Todd)

ADDITIONAL RESOURCES & USEFUL LINKS

Australian Alps Education Kit
https://theaustralianalps.wordpress.com/the-alps-partnership/education/

Australian Government website: Mountain pygmy-possum fact sheet
https://www.environment.gov.au/biodiversity/threatened/publications/factsheet-mountain-pygmy-possum-burramys-parvus-2002

Charlotte Pass Resort; Environment
http://www.charlottepass.com.au/environment.html

National Recovery Plan for the mountain pygmy-possum *Burramys parvus* (PDF 1.4mb)
http://www.environment.nsw.gov.au/resources/nature/recoveryplanMountainPygmy-possum.pdf

NSW Alpine Resorts Environmental Performance report 2013-14 - (see page 20)
http://www.environment.nsw.gov.au/resources/alpineresorts/alpine-resorts-environment-report-2013-14.pdf (PDF 5.74mb)

OEH website: Saving our Species, NSW Government Threatened Species program
http://www.environment.nsw.gov.au/savingourspecies/about.htm

OEH website: NSW Scientific Committee
http://www.environment.nsw.gov.au/committee/AboutTheNSWScientificCommittee.htm

OEH website: Threatened Species
http://www.environment.nsw.gov.au/threatenedspecies/index.htm

OEH website: Threatened species mountain pygmy-possum profile
http://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10114

Perisher Ski Resort: Biodiversity, Helping the Mountain Pygmy-possum at Blue Cow
https://www.perisher.com.au/resort-info/environment/biodiversity

CONTACT & FEEDBACK

We would be grateful to learn of any issues or challenges you may have using the resource and for any other feedback. Also if you have any questions please contact us;

Kosci.Education@environment.nsw.gov.au

Dr Broome's favourite mountain pygmy-possum image. It shows how heavy the little animals can get as they prepare their bodies for torpor during the winter months (Linda Broome)

GLOSSARY

Alpine Area	The area of land where the average daily summer temperature is below 10^{o}C, which makes it too cold for trees to grow. In NSW these conditions start from approximately 1850m above sea level.
Altitude	Elevation/height above sea level (metres).
Aspect	The direction faced by sloping land.
Bogs and Fens	Areas of wetland. Bogs are characterised by the growth of sphagnum moss and receive their water from precipitation. Fens receive their water from groundwater movement and drainage.
Boulder Fields	Also called block streams and block fields. A 'river' or field of rocks that has moved downhill en-masse.
Confound	To cause confusion. In scientific research, factors that may produce unreliable results.
Critically endangered species	In NSW, if a species, population or ecological community face an extremely high risk of extinction in NSW in the immediate future.
Endangered species	In NSW, a species, population or ecological community is likely to become extinct or is in immediate danger of extinction in the wild in NSW. The mountain pygmy-possum is listed as 'endangered' under the NSW Threatened Species Conservation Act (1995) and the Commonwealth Environment Protection and Biodiversity Act (1999).
Endemic	Native or restricted to a certain place.
Geographic Information System	Integrated computer tools for the handling, processing and analysing of geographical data.
Predation	The preying of one animal on others.
Presumed extinct	In NSW, species that have not been seen in nature during the past 50 years, despite the searching of known and likely habitats.
Rank	To give something a place in a grading system or hierarchy.
Spatial data	Information that identifies the geographic location of features and boundaries on Earth and is stored as coordinates and topology and can be mapped.
Subalpine areas	Characterised by snow gum woodland vegetation (approximate altitude range in NSW-1400 m to 1850 m above sea level).
Subnivean	Small air space that exists between the ground and the underside of the snow.
Score	To record a result, usually numerically.
Torpor	A controlled reduction in body temperature and metabolism resulting in decreased physiological activity.
Vulnerable species	In NSW, species that are likely to become endangered unless threats cease.
Water availability	The capacity of a water source (environment) to meet current and additional water demands.