A FLICKER OF HOPE

2022 Bogong moth migration snapshot

AUSTRALIAN CONSERVATION FOUNDATION

The Australian Conservation Foundation acknowledges the Traditional Owners of the ancient lands on which we work.

We pay our respects to Elders past and present and recognise that everywhere we go, we are on stolen and unceded Country.

We acknowledge the deep cultural connections that many First Nations people in the east of this continent have with the Bogong moth and its migration. This report does not seek to represent the experiences and stories of First Nations people.

We also acknowledge the deep time histories of Aboriginal and Torres Strait Islander peoples - the oldest continuing cultures on Earth - and the tireless work by First Nations people to heal Country.

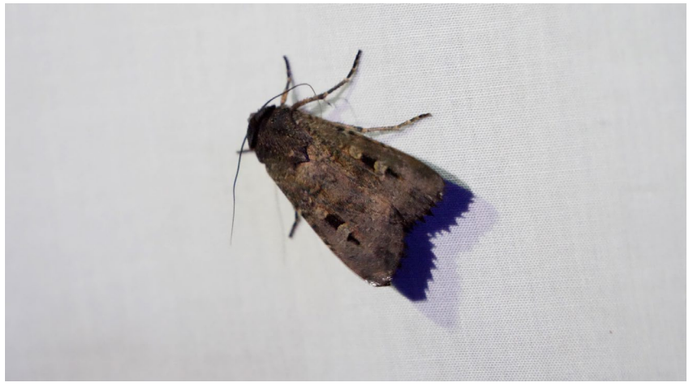
EXECUTIVE SUMMARY

The Bogong moth is a culturally significant and ecologically vital species which once had a migratory population of more than four billion.

But in 2017, after relentless drought, the population of the Bogong moth *(Agrotis infusa)* crashed by up to 99.5%. In December 2021, it was added to the IUCN Red List as an Endangered species.

The once-ubiquitous Bogong moth virtually vanished from the Australian landscape. Not over the course of centuries, but in a handful of years, ringing alarm bells for scientists and everyday Australians.

While Bogong moth numbers seem to have increased, the species still remains at risk from the ongoing threats of habitat destruction and climate change. This report features up-to-date information and commentary from expert scientists about the annual alpine-bound Bogong moth migration.



Bogong moth *Photo:* Tessa Stevens

Key findings include:

- Numbers of Bogong moths appear to be higher across the migratory range compared to the last five years.
- The number of caves occupied by Bogong moths on Mount Gingera in the ACT are on track to match those from before the crash of 2017.
- A third La Niña year has likely assisted the Bogong moth to build up numbers, following a population crash of up to 99.5%.
- The underlying threats of droughts fuelled by a changing climate and habitat destruction from unsustainable agricultural practices remain and will continue to place extinction pressure on this iconic Australian species.

INTRODUCTION

Until only five years ago, Bogong moths were so abundant in numbers they would black out the moon.

The species provided the second biggest input of energy into the Australian Alps—second only to the sun. The 2017 population crash was cause for great alarm, and even though there appears to have been a rebound, the species remains at risk.

Nature in this country is in trouble, and it's not only the Bogong moth that is in danger. Like so many other iconic and once-abundant species, the Bogong moth is in the midst of an extinction crisis. Koalas, black cockatoos, corroboree frogs and quokkas are among the nearly 2,000 plants, animals and ecosystems on the national list of threatened species.

Since colonisation this country has experienced the extinction of more mammals than any other nation, putting Australia third globally for the number of extinct and threatened animals. Despite dire warnings in the 2021 State of the Environment report, bulldozers continue to flatten habitat for agricultural expansion and urban sprawl, placing Australia on the list of global deforestation hotspots.

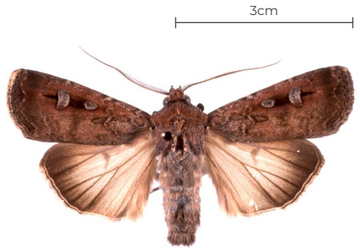
Forests, rivers, wetlands and reefs are in declining health, and our wildlife—most of which is found nowhere else in the world—is under enormous pressure from the combined threats of habitat destruction and invasive species. Climate-fueled disasters like droughts, bushfires and floods are now exacerbating these threats.

Like us, the Bogong moth relies on healthy nature and a healthy climate.

Bogong moth Migration
Photo: Sarah Rees

ABOUT THE BOGONG MOTH

Measuring around three centimetres from head to wingtip, this small insect flies 1,000 kilometres each year, largely at night, to reach the mountains of eastern Australia.



With tiny reflective eyes that are able to ‘read’ the starry night sky like a compass, the Bogong moth further hones its navigational ability by sensing the Earth’s magnetic field.

Taking off from its winter breeding grounds in southern Queensland, western New South Wales and Victoria, the Bogong moth flies towards the Australian Alps. There, billions of moths escape the heat by going into a state of dormancy (known as aestivation) inside cool, high altitude caves.

Each Bogong moth will only fly this alpine-bound journey once in its life before returning to its breeding grounds to mate and die. The species has been undertaking this annual migration for thousands of years and the ecological importance of the Bogong moth to Australia’s alpine country cannot be overstated.

Birds, mammals, lizards and frogs all rely on the annual influx of Bogong moths as a source of summer protein. The critically endangered Mountain Pygmy-possum, Australia’s only hibernating marsupial, largely relies on Bogong moths as a source of nutrition to get through its breeding season. Two species of nematode (or roundworms) feed exclusively on Bogong moths.

For years, the swarms of moths that passed through urban centres like Canberra had been so large that the species was considered by some as a ‘pest’.

However, the species went from billions of individuals to being virtually undetectable.

The population crash of 2017-18 and 2018-19 shows how a once-abundant species can be reshaped in a short period of time by devastating drought conditions exacerbated by climate change. It is a poignant and noticeable example of Australian species in decline and of the apparent global trajectory for many of the world’s insects.

Fig 1: Numbers 1-4 refer to relative abundance of moths with (4) meaning ‘absent’.

Summer	Mt Gingera	Ken Green Bogong	Mt Buffalo	Mt. Higginbotham
2017–2018	4	4	C , §, ¶, ††	4
2018–2019	4	4	4 , §	4

*For Mt. Buffalo

‘C’ indicates the lowest cave where the moths were found.

†† indicates that only a handful of moths were observed.

§ means visit made in January.

¶ means moths only present in the summit cave The Horn.

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Left: Bogong moth at Mt Gingera, ACT
Photo: Daniel Stephenson

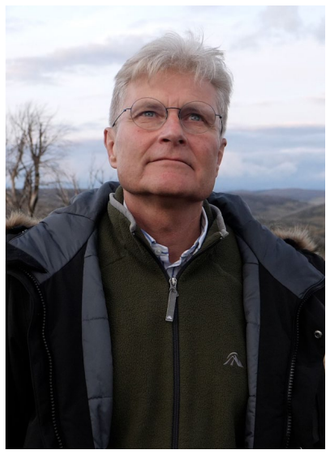
2022 MIGRATION SNAPSHOT

The following data and commentary has been provided to ACF by experts studying the Bogong moth migration.

The following information is an indication of moth numbers at key sites throughout the migration range as of 1st December 2022.

Mount Selwyn and Kiandra
Ngarigo Country, New South Wales.
Data provided by Linnea Rosberg and Eric Warrant, Lund University.

Professor Eric Warrant leads a team of researchers studying the Bogong moth and collecting data through light traps in the Kosciuszko National Park. They investigate the navigational capabilities of the Bogong moth and collect data on numbers via light traps at night.



"I am cautiously optimistic about the moth numbers we are currently seeing entering the mountains at Mount Selwyn. The numbers are better than they've been for quite some time, and on two nights in November vast numbers were observed flying overhead and hundreds landed on our illuminated sheets."

Professor Eric Warrant

Fig 2: Abundance of Bogong moths around Mount Selwyn and Kiandra (NSW)

Date	Abundance of moths on scale from 0–5
15/10-2022	4
25/10-2022	5
02/11-2022	0
03/11-2022	4
05/11-2022	1
08/11-2022	1
09/11-2022	2
12/11-2022	4
15/11-2022	1
16/11-2022	1
18/11-2022	3

Scale: (0) = no months - (5) = very abundant

Left: Professor Eric Warrant
Photo: Tessa Stevens

Above: Professor Eric Warrant during light trapping of Bogong moths on Mount Selwyn
Photo: Tessa Stevens

Mount Gingera
Ngarigo Country, Australian Capital Territory

Data provided by Peter Caley, Senior Research Scientist at the CSIRO.

Straddling the NSW-ACT border on Ngarigo Country, Mount Gingera is the northernmost location where Bogong moths aestivate - "the summer equivalence of hibernation," says Peter Caley of the CSIRO.

"At around 1,850 metres and with granite outcrops and boulders, Mount Gingera is the first mountain of real substance that migrating Bogong moths encounter when travelling from the north. Researchers consider the current maximum January temperatures experienced on Mount Gingera to be around the upper limit of what the moths will choose."

Peter Caley

Mr Caley has been monitoring the moths at Mount Gingera for years. "You could call it a bellwether bogong site," he said. This year, as elsewhere, he has seen more moths.

"Moth numbers atop Mount Gingera have been increasing over the past month, and are now at levels similar to before the severe 2017-2019 drought. That it has taken three years of record-breaking rains for the moth numbers to recover to pre-drought levels (on Mount Gingera at least), speaks to how low the population must have fallen."

Left: Peter Caley *Photo:* Daniel Stephenson
Right: Summit of Mount Gingera
Photo: Daniel Stephenson

Fig 3: Moth numbers as estimated by visual inspection of c. 50 aestivation sites atop Mount Gingera in the Brindabella Range, ACT.

Year	Moth	Notes
2014/15	Moderate	Numbers considerably smaller than historical records from the 1950s.
2015/16	Moderate	Predation by feral pigs documented by Caley and Welvaert (2018) .
2016/17	(Not surveyed)	Very wet 2016 winter driven by negative Indian Ocean Dipole.
2017/18	(Not surveyed)**	Drought starts in earnest in 2017.
2018/19	Very low	Part of a particularly poor year for numbers of Bogong moths across the Australian Alps as documented by Green et al. (2021)
2019/20	Very low	Severe drought continues across most of south-eastern Australia, although some Bogong moths do arrive in the high country from places unknown. Extremely localised heavy rain events, one possibility.
2020/21	Low	Following drought-breaking rains in NSW (though not southern QLD), only a small recovery in moth numbers is observed.
2021/22	None whatsoever	Zero Bogong moths on Bogong Peaks, Mount Morgan nor Mount Gudgenby. The lack of Bogong moths is puzzling on the (numbers Main Range are very low), given the second consecutive year of above average autumn/winter rains post-drought.
2022/23	Moderate (as of mid-November)	Following a third year of above-average rainfall the Bogong moth population finally appears to be recovering to pre-drought levels.

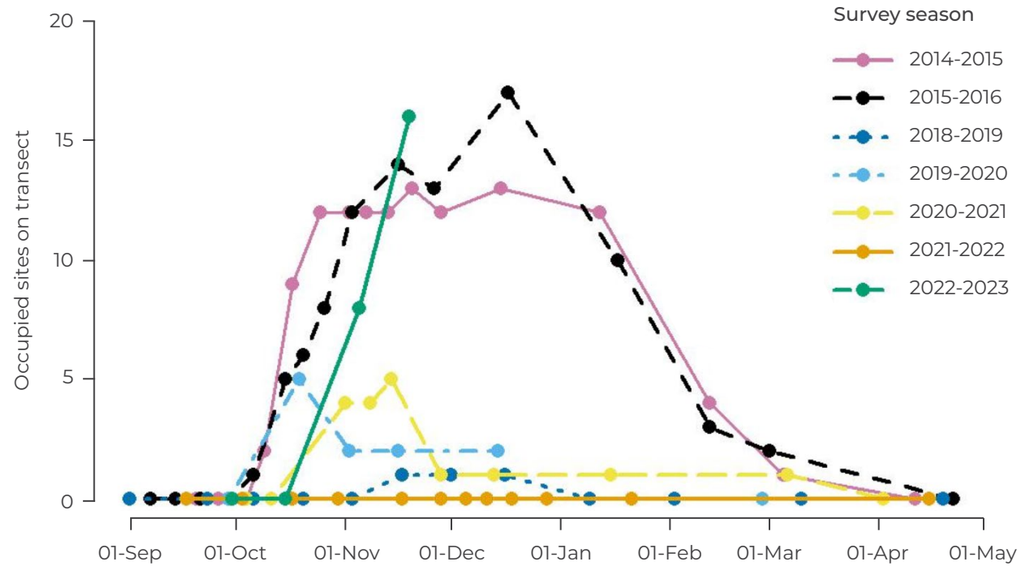
*Numbers are relative to descriptions from about 1980 gleaned from Common (1954) and Flood (2010) , after which the trend in numbers appears to have started declining.

**Not surveyed by the author of this dataset. Monitoring undertaken by others and moths found to be absent from sites surveyed at Mount Gingera.

“Moth numbers atop Mount Gingera have been increasing over the past month, and are now at levels similar to before the severe 2017-2019 drought. ”

Peter Caley

Fig 4: Number of sites occupied by Bogong moths on transect - Mount Gingera



*Data compiled from Caley & Welvaert (2018), Green et al (2021) and Caley (unpublished data).

Left: Bogong moths
Photo: Daniel Stepheson

Mount Hotham
Gunaikurnai and Taungurung Country, Victoria

Anecdotal evidence provided by Bev Lawrence, Environmental Services Coordinator, Mount Hotham Resort Management Board.

Bev Lawrence has been working at Mount Hotham in Victoria's alpine country for 44 years. She has witnessed the impressive spring and summer swarms of Bogong moths over those decades, noticing a gradual decline in numbers over the last ten years, and a steep reduction in the last five years.

Bev has anecdotal evidence about Bogong moths at Mount Hotham—the place where Mountain Pygmy-possums were famously 'rediscovered' in the 1960s, having been thought to be extinct.

"The first day when we noticed a lot of moths this year was 17 November. We counted about 200 or so moths in the tourist shelter. The next day we counted about 300. We then turned the shelter lights off and that's when the numbers in the shelter dropped to about 20 or so over the following days. Hopefully they have found their way to the boulder fields and our possums."

Bev Lawrence

Bottom Left: Bev Lawrence
Photo: Provided by Bev Lawrence

Right: Bogongs in gas metre box at Hotham tourist shelter
Photo: Provided by Bev Lawrence

"Over the last few weeks, we've seen a stable population of 20 or so tucked into nooks and crannies around places like in the lunchroom. But significantly more than in the last few years.

So we're thinking cautiously, is this a good sign? Or is it too early to tell? We opened up one of the gas metres and found a huddle in there too.

"We are seeing significantly more than last year and previous years. We are quietly excited."

Moth Tracker - Citizen science-sourced information

Data provided by Zoos Victoria

Dr Marissa Parrott is a Reproductive Biologist at Zoos Victoria. She has provided commentary about the moth sightings via Zoos Victoria's citizen science page Moth Tracker.

"We have been thrilled to receive so many sightings through Moth Tracker this year. From the 15th of September to the 17th of November, 403 moth sightings were submitted to Moth Tracker. 230 of these sightings were verified to be Bogong moths.

During the same time period in 2021, there were only 45 verified sightings. This reflects reports from our partners in the alps that numbers are thankfully looking better this year, though they are still frighteningly low compared with years prior to the collapse in 2017."

- Zoos Victoria received a total of **459** Moth Tracker submissions, with **259** verified as Bogong moth sightings (as of December 1st, 2022).
- The active season won't conclude until the 31st of December, however, Bogong moth sightings have already far surpassed previous years. Previously, the highest number of Bogong moth sightings was recorded in 2019.
- With one more month of the active season still to go, already the number of verified Bogong moth sightings recorded on Moth Tracker is **74 per cent** greater than the total 2019 season, and an impressive **236 per cent** increase on the 2021 season.
- Currently, **56 per cent** of sightings submitted to Moth Tracker this season are confirmed to be Bogong moths.
- This is on track to be Moth Tracker's best year yet in this regard too; by comparison at this time in 2021, **44 per cent** of Moth Tracker sightings were verified as Bogong moths.

However, it remains important to keep taking photos of any Bogong Moths you see and logging them through Moth Tracker to gain data as they reach the alpine zone, and to track them when they head back to their breeding grounds again in autumn."

Right: Dr Marissa Parrott
Photo: ZoosVictoria

Above: Bogong moths on Mt Gingera, ACT
Photo: Daniel Stephenson

"Our actions to help protect and recover this species in our own backyard can affect wildlife and wild places far removed from our local area. For example, what happens in southern Queensland can affect the survival of tiny Mountain Pygmy-possums in their alpine boulder-field homes."

Dr Marissa Parrott

THREATS AND CASCADING IMPACTS

Bogong moths face two key threats - habitat destruction and climate change. Habitat destruction in some of the species' remote breeding grounds of southern Queensland, northwest and western NSW, western Victoria and eastern South Australia is impacting Australia's delicate alpine ecosystems up to 1,000 kilometres away.

In the Murray-Darling Basin, the main winter breeding grounds of the Bogong moth, land clearing for unsustainable agriculture has long had an impact on species numbers.

These large-scale changes in land use and farming practices in the moths' breeding grounds are thought to be responsible for removing half a billion Bogong moths annually.

However climate change remains the biggest threat to the Bogong moth, and the extreme drought conditions that came to a head in 2017 are testament to this.

In the years following, Mountain Pygmy-possums were found to be starving and losing their young while still in the pouch. The national recovery plan for the Mountain Pygmy-possum lists the decline of Bogong moths as one of the threats to the critically endangered marsupial.

By 2021, the international community was watching, and the Bogong moth was one of 124 Australian species to be added to the IUCN's Red List of Threatened Species.

Now in 2022, Bogong moths appear to be returning in healthier numbers, but the science is clear—global temperatures are rising making extreme weather like droughts more severe, frequent and unpredictable. In order to secure the species' long-term survival, the dual threats from climate change and nature destruction must be addressed to avoid another Bogong moth decline of magnitude.

CONCLUSION

While this report contains a flicker of hope that Bogong moth numbers are starting to increase, the undeniable trajectory for the species, like so many other Australian plants, animals and ecosystems, is declining.

While the species appears to be clawing its way back from the brink of extinction, this does not mean we can ignore its plight. Hopeful signs of recovery are all the more reason we must address the underlying threats to the Bogong moth's existence - habitat destruction from unsustainable agriculture and climate change.

If Australia is to reverse the extinction crisis we must halt nature destruction and restore ecosystems to better health by 2030.

The Federal Government must create strong new environment laws that actually protect nature and an independent and well-resourced regulator to enforce them .

The Federal Government must also invest in restoring Australia's wildlife and ecosystems. Spending $2 billion annually for 30 years could restore and protect almost all (99.8%) of Australia's degraded terrestrial ecosystems to at least 30% of their original coverage.

Nature needs us, now.

Above: Bogong moth
Photo: Jean-Paul Ferrero/AUSCAPE

Left: Mountain pygmy-possum - Burramys parvus
Photo: Australian Alps collection - Parks Australia

ACKNOWLEDGEMENTS

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Bev Lawrence
Marissa Parrott
Hannah Sly
Ken Green
Naomi Monk
Kate Umbers

Right: Bogong moth resting on a tree
Photo: CSIRO

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For Figure 4

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For Figure 5

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