The recent heatwaves have proved deadly to many Australian animals, from feral horses to flying foxes.

And it's not just heatwaves that can cause mass die-offs. Last year, flooding rain wiped out entire Antarctic penguin colonies, while drought has previously caused mass mangrove diebacks around the Gulf of Carpentaria.

These events generate headlines, but what about the aftermath? And are these catastrophic events part of a wider pattern?

---

***Read more:*** ***Killer climate: tens of thousands of flying foxes dead in a day***

---

Our research describes how species have responded to extreme weather events over the past 70 years. These responses can tell us a great deal about how species are likely to cope with change in the frequency and intensity of extreme events in coming years.

We reviewed 517 studies, dating back to 1941 and conducted throughout the world, that examined how birds, mammals, fish, amphibians, reptiles, invertebrates or plants have responded to droughts, cyclones, floods, heatwaves, and cold snaps.

We found more than 100 cases of dramatic population declines. In a quarter of these cases, population numbers showed no sign of recovery long after the event. And in most cases, extreme events reduced populations of common species that play an important role in maintaining ecosystem integrity.

For example, extreme drought in the 2000s drove massive population declines of invertebrate freshwater species across Australia’s Murray-Darling Basin , and populations of buffalo, waterbuck, and kudu along the Zambezi River in Zimbabwe suffered severe and persistent declines following droughts in the 1980s .

We also found 31 cases of populations completely disappearing after an extreme event. Large populations of lizards and spiders were eradicated after Hurricane Lilli struck the Bahamas in 1996 , for example. These populations had begun to recover one year after Lilli, but in half of all the cases of local population extinction, the species was still absent years or decades after exposure to an extreme event.

Negative responses were the most commonly reported, and also included habitat loss, declines in species numbers, and declines in reproductive fitness after an extreme event. These impacts clearly pose a serious risk to the longevity of many species, and to threatened species in particular. Kosciuszko National Park, for example, is a stronghold for the endangered northern corroboree frog, but 42% of its breeding sites in the park were rendered unusable by severe drought conditions throughout the 2000s.

## Is there an upside?

Alongside the many negative impacts, we also found a larger-than-expected number of positive or neutral responses to extreme events (21% of all responses). This is a reminder that natural disturbances from extreme events often play a crucial role in the natural dynamics of an ecosystem.

Unfortunately, however, in many cases it was invasive species that benefited from extreme events. Flooding in southern Minnesota in 2004, for example, led to the rapid incursion of invasive green sunfish into streams , and cyclones accelerated the invasion of sweet pittosporum in Jamaican rainforests in the 1990s .

Cases of extreme events benefiting threatened species were uncommon, but included rainforest frogs becoming less susceptible to a fungal pathogen, chytrid fungus, after cyclones reduced rainforest canopy cover.

We also identified a range of “ambiguous” responses, including changes in diet or foraging behaviour, and changes in the types of species inhabiting a study area. Changes in invertebrate communities were particularly prevalent (87 cases). In 18 of these cases, the changes were long-lasting. However, most of the studies we reviewed lasted less than one year, and did not monitor for long-term recovery following an extreme event. This limits our ability to assess the long-term implications of extreme events on the species composition of ecosystems.

## Avoiding future impacts

The one failsafe option for helping species cope with extreme events is to retain intact habitats, as these are the places where species are most resilient to extreme events . Intact habitats are contiguous areas of water or native vegetation that often span various altitudes, temperatures and rainfall patterns. These places can also act as important refuges for species that rely on long breaks between extreme events to recover.

Where intact habitat protection is not possible, restoring land or seascapes can also help species to adapt to extreme events. For example, long-term restoration efforts (that is, those that will be effective for at least 15 years) in brackish marshes help plant and animal communities cope with drought events.

Ecological restoration that helps species to adapt to extreme events can also benefit humans too . For instance, coastal communities can use oyster reefs or seagrass beds to guard against flooding.

---

***Read more:*** ***Ecosystems across Australia are collapsing under climate change***

---

Climate change has already increased the intensity and frequency of extreme events across the world, and the trend is expected to accelerate in the future. Recognising the importance of planning for extreme events is essential for helping species cope with climate change. Building resilience to extreme events may also provide an opportunity to reduce the vulnerability of humans too.

Governments, local councils, and local communities are under increasing pressure to plan for extreme climate events. We now need similar recognition of the importance of extreme events in threatened species planning efforts. Right now, this planning is virtually non-existent, and that needs to change.

*Sean Maxwell has previously received funding from the Australian Research Council*

*James Watson receives funding from Australian Research Council, the Science for Nature and People Partnership and the National Environment Science Program. He is Director of Science and Research at the Wildlife Conservation Society.*

Authors: Sean Maxwell, Postdoctoral fellow, The University of Queensland

**Read more** http://theconversation.com/when-extreme-weather-wipes-out-wildlife-the-fallout-can-last-for-years-109191