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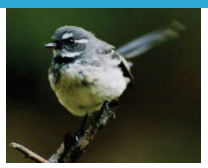


INFORMATION SHEET FOUR

Habitat Refugia: A Practical Strategy to Conserve Biodiversity Under Climate Change

As climatic zones shift under climate change, many regions and habitats will slowly become climatically unsuitable for some of the species that currently inhabit them. The availability of climate refugia - habitats and regions which are buffered from extremes in temperature and fluctuations in water availability, could allow some species to adapt to climate change *in-situ*, and facilitate dispersal and range shifts for other species.

This information sheet explains the concepts behind habitat refugia with specific reference to how refugia can be used to protect and conserve terrestrial biodiversity faced with rapid climate change.

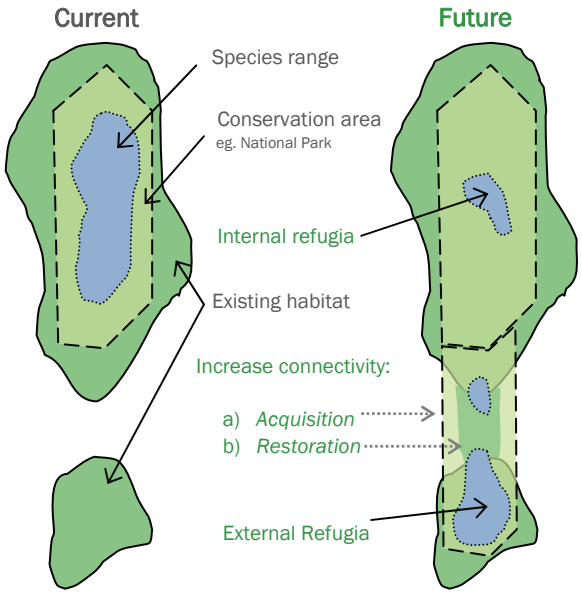
What are Habitat Refugia?

Habitat refugia are areas within the landscape which are naturally buffered from extreme variation in environmental conditions, such as protected slopes on mountains, valleys, or forests with extensive shading canopy.

The term 'refugia' was originally used to describe regions where species survived after the last glacial period - such as pockets of high elevation rainforest in Queensland's Wet Tropics.

But increasingly the term is used to refer to regions and areas that are expected to retain more stable climates, and associated species and assemblages, that are being lost elsewhere as a consequence of contemporary climate change.

Areas in the environment with extensive canopy and/or valleys and slopes can be buffered from extreme environmental conditions and can act as 'refuges' for terrestrial species as the climate changes (© S. Williams).



Schematic diagram demonstrating the concept of internal and external habitat refugia now, and in the future under climate change.

Refugia may exist outside current conservation areas or species ranges.

Types of Refugia

Habitat or climate refugia can be considered at two broad spatial scales:

- **Macrorefugia** - large scale areas which retain a stable temperature, protected from rapidly changing highs or lows, such as mountains, valleys or forests.
- **Microrefugia** - smaller areas protected from temperature fluctuations, such as valley floors, boulder fields or tree hollows.

Climate models can help identify refugia within the landscape; in some refugia, temperatures can be up to 6°C cooler than ambient surrounding temperatures.

- **Internal Refugia** - are locations expected to remain climatically suitable which occur within the current geographic range of a species.
- **External Refugia** - are previously unoccupied locations that are expected to become favorable under future conditions.

Internal refugia will require least intervention, especially for species with poor dispersal capabilities. However internal refugia will also need to be big enough to support a viable number of individuals if the population contracts from its former range.

Natural colonisation of external refugia might not be possible for species with poor dispersal capabilities, that are restricted to fragmented habitats and/or have range-shift routes blocked by physical barriers - these species may require more intensive management.

Refugia Design and Connectivity

Climate models can identify potential refugia, and provide clear guidance as to where conservation activities should be targeted.

Habitat restoration also has the potential to increase the local extent of refugia by consolidating and connecting existing areas of prime habitat in fragmented landscapes.

Indeed, habitat connectivity should be a key issue underpinning the design of reserves which will promote habitat refugia. For example:

- Connectivity will allow good dispersers to shift their ranges and track their optimal thermal conditions.
- Habitat restoration and corridors will allow good dispersers to move into external refugia, and avoid physical barriers to dispersal such as rivers, roads, etc.
- Connected ecosystems and refugia will allow the formation of novel ecosystems.

Cassowaries will benefit from rainforest refugia linking key habitats (© G.Calvert).

Challenges and Key Considerations

As climates shift, the number and size of refugia will likely decrease, and remaining patches may become increasingly isolated. This will pose challenges for conservation planning to maximize persistence of species through time in refugia. Restoring and/or enlarging internal refugia could reduce the likelihood of population decline as species contract into refugia as the climate warms.

However, simply increasing the area and quality of habitat may not be enough - conditions within some existing protected areas may become unsuitable for some species and dispersal distances between patches of thermally preferred habitat will be too great to be accommodated simply by increasing the size of protected areas. In this case, future land acquisitions and restoration efforts will be most effective where they promote connectivity among isolated patches of suitable habitat. Many mobile species respond positively to habitat corridors.

Key Ideas:

- Bolster resilience of **internal refugia**
- Increase **connectivity** to **external refugia**
  - through acquisition of conservation areas
  - through restoration of corridors

Implications for Managers and Decision-makers

Although protecting climate refugia has become a common recommendation for conserving biodiversity under climate change, it is often proposed as a general principle and rarely translated into specific practices on the ground.

The science of habitat refugia is in its fledgling stages, and a number of considerations are necessary to plan for protecting and creating climate refugia. These include identifying robust technical strategies to detect climate change refugia, incorporating climate refugia into conservation plans, and also identifying specific management interventions that could protect and restore priority refugia.

At present, many existing protected area networks are biased toward particular landscape features such as steep and infertile parts of public land. Therefore, locations that function as refugia and habitat connections will not necessarily be adequately represented, and new investment will be required in many regions. Formal agreements between landholders and government may provide a low-cost mechanism to protect existing forest on freehold land. Consideration should also be given to the optimal shape and size of refugia required to promote the persistence of a species of interest.

Finally, natural colonisation to external refugia may not be possible for some species, such as poor dispersers, or those restricted to isolated mountain tops. In such circumstances, assisted migration may be required to move these species to suitable external refugia and avoid extinction in the wild.

About the Adaptation Research Network for Terrestrial Biodiversity

The Adaptation Research Network for Terrestrial Biodiversity is one of eight research networks administered by the National Climate Change Adaptation Research Facility. It is hosted by James Cook University in Townsville, North Queensland.

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For more information on the Climate Change Adaptation Research Facility and other Research Networks, please visit www.nccarf.edu.au

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